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VOLUME II

CLINICAL TUBERCULOSIS

CLINICAL TUBERCULOSIS

BY

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VOLUME II

COMPLICATIONS AND TREATMENT

SECOND EDITION

WITH SIXTY-FIVE TEXT ILLUSTRATIONS AND CHARTS, AND FOUR PLATES IN COLORS

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CHAPTER XXIII.

TUBERCULOUS LARYNGITIS

One of the triumphs of modern medicine is the removal of tuberculous laryngitis from the list of incurable affections, and placing it among the curable.

Larynx Ideal Place to Observe Tuberculous Process.—Tuberculous laryngitis offers an ideal opportunity for observing the development and progress of tuberculous infections. My observation of laryngeal tuberculosis taught me many important facts which have led to a better understanding of the disease in general. It was here that I was impressed with the slowness, and, again, the rapidity with which a tuberculous process may at times develop. I have seen infiltrations appear and remain as such for many months, then to be transformed into scar, or to ulcerate; the ulceration being followed by either healing or progressive destruction. On the other hand, I have observed a laryngeal infection to come on and within a very short time to show a severely destructive process.

It was here also that I had the fact impressed upon me that the conservative changes, in response to the therapeutic measures, are exceedingly slow, slight lesions often requiring a period of six or more months before healing is accomplished, and severe lesions often requiring a year or more. It is necessary to understand the slowness of these changes; otherwise, a failure to accomplish the desired result may be alone due to the lack of persistence. I have seen many lesions heal in eight months that would have been classified as failures in six; others in a year and two years, that would have been failures in shorter periods. The importance of courage and persistence in the treatment of tuberculosis cannot be better impressed on one than by observing the larynx.

It was in the larynx, too, that I was first impressed with the action of tuberculin. Here, under direct observation, I saw focal reactions and learned their diagnostic value, and also gained many valuable ideas as to the therapeutic action of tuberculin, particularly as to the increase of dosage and the interval between individual doses.

Inspection of the larynx is an important part in the routine examination in pulmonary tuberculosis. Infection of this organ is a very common complication and is often present when unsuspected. Clinically, there are no constant symptoms to make its presence felt. The symptoms will depend on the location and extent of the lesion. Neither pain nor hoarseness can be relied upon for suggesting its presence; for both of these are often found in the larynx of patients without tuberculous laryngitis; and, many cases of tuberculous laryngitis are found without either pain or hoarseness.

Frequency of Tuberculous Laryngitis.—The actual frequency of infection can be determined only by routine laryngoscopic examinations during life and by careful examinations postmortem. There is a wide discrepancy between the results of clinical and postmortem examinations. This is partly due to the greater exactness of the postmortem examination and partly due to the fact that the clinical examinations are made earlier in the course of the disease while all postmortem findings are after all possible infections have occurred. It is not uncommon to find a general dissemination of infection to occur during the last few weeks of life, and the larynx is often involved at this time when it has been previously free.

Various clinical observers report from 10 to 50 per cent of laryngeal infection among their pulmonary cases. Besold and Gidionsen[1] report 498 or 26.73 per cent of cases of unquestioned diagnosis in a pulmonary material of 1863 cases; and, 250 or 13.42 per cent more in whom there was some question about the diagnosis in the minds of the observers. In a former paper[2] the writer reported 61 cases of laryngeal infections, making 29.3 per cent in 208 patients who remained in the Pottenger Sanatorium during the years 1906 and 1907 for a minimum period of three months. About this same average has continued throughout the entire twelve years that the institution has been open. If we were to count all patients entering the institution the percentage would be somewhat larger because most of those, whose stay is less than three months, belong to the very ill class.

---

[1] Pathologie und Therapie der Kehlkopf-Tuberkulose, 1907.

[2] Prognosis and Treatment of Tuberculous Laryngitis: An Analysis of Sixty-one Cases, California State Journal of Medicine, October, 1908.

The material of different institutions will necessarily differ greatly. Those in which there is a large proportion of advanced cases will show the largest percentage of laryngeal involvement. This will depend somewhat too on the age and sex of the patients, as is well shown in the Tables I and II, taken from Lake's monograph[3] on the subject.

TABLE I.

Showing Proportion of Infection in Males to Females

AUTHOR	NUMBER OF CASES	PROPORTION	
		MALES	FEMALES
Mackenzie	500	2.7	1
Magenau	400	2.17	1
Heinze	376	1.5	1
Rosenberg	....	2.4	1
Besold	....	2.62	1
Schmidt	2,156	2.45	1
Author	667	2.44	1

TABLE II.

Showing Percentage of Laryngeal Ulceration Among Cases of Pulmonary Tuberculosis According to Age Periods

AGE	PULMONARY PHTHISIS	LARYNGEAL ULCERATION	PERCENTAGE OF LARYNGEAL CASES
Under 1 year	13	1	7.7
1-10 years	39	4	10.25
11-20 years	92	23	25.0
21-30 years	406	130	32.0
31-40 years	303	112	36.96
41-50 years	179	67	37.43
51-60 years	104	27	25.96
61-70 years	53	9	17.17

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[3] Laryngeal Phthisis or Tuberculous Laryngitis, William Wood & Co., New York, 1905.

Cause of Laryngeal Infection.—The facts brought out in these two tables are difficult to explain. It would appear that there is something in the life and habits of men, as compared with women, which makes their larynges more prone to infection. Whether this is in the general or local resisting power of tissues or whether conditions are present in the larynx of the male which favor implantation of bacilli, that are not present in that of the female, is uncertain. The larynx of the male is doubtless exposed to more injurious influences on account of the conditions under which he must work; yet my observations would not indicate that those who work in dusty occupations are any more prone to laryngeal involvement than those who do not. It would be in accordance with our theory of laryngeal infection being a surface infection, to assume that there is something in the male, as compared with the female, either in the relative resisting power of the laryngeal tissues which invites penetration by the bacilli, or in the size and shape, or in the innervation of the organ itself, which favors a longer contact of the bacilli. Either of these conditions would favor implantation. Could it be that the comparatively large larynx of the male permits of greater surface contact or longer surface contact of sputum without inciting the cough reflex or without encroaching upon the glottic clink, so as to make it imperative on the part of the patient to clear it away; or, is there a lessened sensibility in the male larynx, as compared with the female?

It is further interesting to note in Table II that the incidence of involvement of the larynx is not coextensive in point of age with the pulmonary involvement. While the greatest number of infections in the larynx in the above table appears in the decade 21-30 years; yet this is not the largest percentage when comparing the total number of laryngeal infections with the total number of pulmonary infections as shown in column four. Laryngeal tuberculosis belongs to a riper age than pulmonary tuberculosis. An explanation of this might be found in the increased chronicity of tuberculosis during the 30-60 year period, as compared with that prior to this; the greater chronicity favoring infection by increasing the amount of contact and the time of contact of the bacillus laden sputum with the tissues and causing reflex trophic changes through the laryngeal nerves.

The difference in the incidence of tuberculosis of the larynx determined clinically as compared with that found postmortem may be realized by comparing the above clinical diagnoses with the pathological findings of Kidd and Heinze.

Percy Kidd[4] writing in Allbutt's system, says infection of the larynx was found by him in 50 per cent of all cases postmortem.

Heinze is quoted by West[5] as having examined fifty consecutive cases of fatal tuberculosis postmortem, and finding only three in which tuberculosis did not exist in the larynx, trachea, or both. It was found in the larynx alone in 23, in both larynx and trachea in 24; in trachea alone in 2.

Methods of Invasion.—Primary tuberculosis of the larynx was formerly reported comparatively frequently; but the majority of such cases will not bear investigation. Richard Lake quotes the paper by Aronsohn[6] who collected thirty-four cases of reported primary tuberculosis of the larynx from the literature. After carefully examining the cases he states that only three of them were proved postmortem to be tuberculosis and not to have tuberculosis of the lungs. Nine showed, postmortem, an old lesion in the larynx and a recent process in the lungs, and twenty-four were reported clinically without signs being found in the lungs. Lake reports two cases from his own practice extending through the eustachian tube from an infection in the ear.

The meaning of primary infection of the larynx today is somewhat different from what it was a decade or more ago. At that time it was supposed to be the only focus in the body, but now it means an infection of the larynx, the lungs being free.

From our study of infections we can understand how bacilli coursing through the blood stream might be strained out in the capillaries of the larynx, the same as any other organ or part. At the same time this organ must be extremely rarely infected in this manner.

We now and then see a miliary infection of the larynx as a part of a general miliary process. Such a case is under my care at the present time. The patient had suffered from a slightly active pulmonary tuberculosis for more than two years; when, following acute caseation, there was a general dissemination throughout both lungs, the larynx, pharynx, both ears, meninges, and probably the intestinal tract.

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[4] Allbutt and Rolleston: System of Medicine, Macmillan Co., New York, 1909.

[5] Diseases of the Organs of Respiration, London, 1902.

[6] Archiv für Laryngologie und Rhinologie, Bd. v, 1896, p. 210.

Nearly all cases of laryngeal tuberculosis are found in patients with open pulmonary tuberculosis. This fact suggests surface infection as the method of invasion. The fact that the lesion is most commonly on the side of the lung lesion or the more serious lesion when both lungs are involved suggests definite relationship between the pulmonary and laryngeal lesion. This we find in the trophic changes which are reflexly produced through the laryngeal nerves when the lung is chronically inflamed.

The tuberculous infection of the larynx has the same characteristics as that of the intestines in adults. *It follows the rule noted by Koch in the guinea pigs which are reinfected; that is, it is limited to the tissues where implantation occurs without the neighboring glands becoming infected.* It is rare in either of these complications to find the lymphatic glands which receive drainage from the infected structures to participate freely in the pathological picture.

The larynx is not connected with the lung anatomically, either through the blood or lymph stream sufficiently directly to warrant frequent infection through these channels, although there is nothing to prevent such an infection from occurring now and then. The great mass of laryngeal infections, however, come on after the ulcerative stage has been reached in the lung and after the bacillus-bearing secretions have had an opportunity to pass over the surface of the larynx. *This suggests surface infection as being the probable explanation of the frequency of involvement in this organ.* This is also suggested by the fact that infection is most common in the posterior portion of the larynx where the contact with sputum is greatest as is shown in Table III, taken from a former paper by the writer.[7] The posterior wall was affected to some degree in every case there reported.

This fact is also shown in the analysis of the 498 cases reported by Besold and Gidionsen referred to above. The posterior

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[7] Prognosis and Treatment of Tuberculous Laryngitis: An Analysis of Sixty-one Cases, California State Journal of Medicine, October, 1908.

TABLE III.

SHOWING DIFFERENCE IN PROGNOSIS OF TUBERCULOUS LARYNGITIS ACCORDING TO THE LOCATION OF THE LESION

LOCATION OF LESION	NO.	APPARENTLY CURED		ARRESTED		IMPROVED		UNIMPROVED	
		NO.	%	NO.	%	NO.	%	NO.	%
Interarytenoid space.	10	10	100	.....	.....	.....	.....	.....	.....
Int. space and arytenoids	13	13	100	.....	.....	.....	.....	.....	.....
Int. space, aryt. and cords	22	6	27.27	1	4.55	14	63.18	1	4.55
Int. space, aryt. and ventricles	1	1	100	.....	.....	.....	.....	.....	.....
Int. space, aryt., cords and ventricles	8	1	12.5	1	12.5	5	62.5	1	12.5
Int. space, aryt., cords, ventricles and epiglottis	7	1	14.25	.....	.....	3	42.82	3	42.82

wall of the larynx was infected alone in 107 cases; in conjunction with both vocal cords in 87 cases; with one cord in 53 cases; and in combination with other parts of the larynx in 98 cases. Since the table omits to show the location of the infection in 71 cases, this gives us a total of 345 infections of the posterior wall out of a material of 427 cases; or a percentage of 83.

Prognosis.—The most important factor in the prognosis of tuberculosis of the larynx is the extent and character of the accompanying pulmonary lesion and the general reacting power of the patient. A slight or moderate infiltration will nearly always heal in a patient in whom the disease has not seriously undermined the general constitution; while, if the pulmonary condition is active and the disease is spreading, with a general reduction in the strength of the patient then more than improvement on the part of the larynx must not be expected.

A severe infiltration or ulceration offers a very fair prognosis in patients in whom the pulmonary involvement is neither extensive nor markedly active providing the general reacting powers of the patient are good; and, providing, in case of ulceration, the ulcer is so situated as not to cause dysphagia and interfere with nutrition. In many cases of advanced pulmonary tuberculosis the larynx will heal although the lungs do not.

In progressive, rapidly extending, pulmonary tuberculosis, the prognosis in laryngeal infection is bad, and little can be expected of treatment beyond the relief of the most urgent symptoms.

The prognosis also depends very much upon the character of the lesion. Slight infiltrations or ulcerations offer excellent prognoses; moderate infiltrations and ulcerations offer a prognosis less favorable; while in severe progressive infiltrations and ulcerations the prognosis is grave. Those lesions associated with perichondritis are particularly grave.

The location of the lesion also has a very important bearing on prognosis. Those portions of the larynx which are best supplied with blood and lymph yield most readily, probably because the protective substances which are elaborated by the body cells are applied more directly to the focus. Lesions in the interarytenoid space, and those running up on the arytenoids themselves yield more readily than do those which involve the cords, ventricles and epiglottis. Lesions of the epiglottis are particularly grave both because of the pain and because of the interference with deglutition.

The influence of healing of the larynx upon the general tuberculous process must not be overlooked. The laryngeal complication, particularly if it produces aphonia, has a very depressing effect upon the patient. The depressing effect of the pain, which is sometimes excruciating, can readily be understood; and the effect of its relief upon general prognosis is evident.

Diagnosis.—Diagnosis of tuberculosis of the larynx is not as simple as might seem. The difficulty is particularly great where the patient is not known to be suffering from pulmonary tuberculosis. Patients who suffer from tuberculosis have many laryngeal conditions which are confusing.

In many instances there is a chronic thickening, particularly of the cords, which is brought on by different conditions present in the larynx, such as irritating discharges and repeated coughing. It is, at times, extremely difficult to differentiate between a tuberculous involvement and a simple involvement under such circumstances. When other portions of the larynx are involved, however, the difficulty is not so great.

Hoarseness.—Hoarseness is a common symptom of tuberculosis of the larynx but is often present during the course of pulmonary tuberculosis as a result of other causes.

A slight hoarseness is often found as a symptom of early tuberculosis of the lung, and when the larynx is examined for a weak voice, or slight hoarseness, if the picture is that of a general relaxed condition of the cords or an interference with adduction, it should call for an examination of the chest before a diagnosis is made; for this is an extremely common result of reflex irritation of the laryngeal nerves, the afferent impulse coming from the inflammation in the lung. In cases of marked shifting of the mediastinum, hoarseness and aphonia are often present.

Under the discussion of the Symptoms and Physical Signs in Pulmonary Tuberculosis (Volume I, page 385) I discussed at some length the reflex interference with the innervation of the larynx, through both the superior and inferior laryngeal nerves, which is produced by the inflammation in the lung, and showed how both a relaxed condition of the cords and an interference with adduction may result from this reflex cause. I have seen this reflex disturbance so great during acute cavity formation that complete aphonia was present over a period of several days. Huskiness, at times, may also be due to tenacious mucus collecting on the cords. Hoarseness in tuberculosis of the larynx may not be confined to infection of the cords. Sometimes tumefactions in the interarytenoid space will prevent approximation; at other times infiltration and bulging of the ventricles are accountable for it; and, still again, an involvement of the arytenoids themselves may be sufficient to interfere with approximation.

Pain.—Pain is a very common symptom in tuberculosis of the larynx, and while it is usually discussed as being present during swallowing, pain is also sometimes present when the larynx is at rest. It is not uncommon for this pain to radiate toward the ear, especially when the epiglottis, the arytenoids, or the ventricles are the seat of the infiltration or ulceration.

Aside from the pain present during and depending upon tuberculosis of the larynx, a similar one is at times found during the course of tuberculosis of the lungs when the larynx is free from infection. This is particularly true in old chronic cases. I have had patients complain of this pain radiating to the ear in whom repeated examination revealed no visible laryngeal involvement. My explanation of the symptom is that it is a neuritis affecting the laryngeal nerves, of reflex origin, the same as the neuritis which is now and then found in the shoulders in the presence of old chronic lesions.

Painful Deglutition.—Painful deglutition may be a pronounced symptom in advanced ulcerative tuberculous laryngitis, no matter where the location of the ulcer. It is particularly painful when situated on the epiglottis and in the ventricles, and less so when involving the arytenoids or interarytenoid space and cords. It is also painful when perichondritis is present. Whenever infiltration or ulceration are widespread, difficulty in swallowing is apt to be encountered. The parts become inflexible, and often when the epiglottis is involved, food will be forced forward into the nares, causing great discomfort; and, at times, the food passes down into the larynx, causing cough and strangling.

Cough.—Cough is a common symptom and, at times, becomes extremely distressing to the patient, disturbing rest and retarding progress. The cough often assumes a different quality, according to the part affected. The physician who has had wide experience in treating tuberculosis of the larynx can guess with a degree of accuracy as to the location of the lesion when he once hears the patient cough.

Obstruction to Respiration.—Obstruction to respiration is now and then feared in tuberculosis of the larynx. In my experience I have seen only one case, however, where I felt anxiety regarding this, and in this case the symptoms were so urgent that we were ready to make a tracheotomy at any time should necessity present; but, after a few days' acuteness, the obstruction passed away and no further danger was threatened.

Secretion.—In some cases of tuberculosis of the larynx there is a diminution of secretion, the patient suffering from considerable dryness of the part. Far more commonly, however, we find an increase in the amount of secretion when the larynx is involved. This, at times, amounts to several ounces per day. It is usually most marked when a severe ulceration is present and produces great discomfort by causing a continuous desire to swallow or expectorate. This secretion is, for the most part, thin and watery.

Examination of the Larynx.—The laryngoscopic examination is a very important procedure in diagnosis. While a tuberculous involvement may often be suspected by the clinical history, yet the diagnosis should not be made until the larynx is carefully inspected; and, even then, doubt will at times exist. Any part of the larynx may be affected, and the infection may show all the different pathological changes from miliary tubercles to severe ulcerations. The greatest factor in diagnosis is experience.

Syphilis, malignant growths, and chronic simple laryngitis are to be differentiated from tuberculous laryngitis. This task is not always an easy one. The fact that tuberculous laryngitis is practically always secondary to an open pulmonary lesion is of great importance. I would caution, however, that the presence or absence of the pulmonary lesion be determined by careful examination. Too often pulmonary tuberculosis is excluded by superficial and insufficient examination. The service of an expert should be obtained in case of doubt. It was formerly taught that tuberculous laryngitis could be differentiated from syphilitic by the difference in localization; syphilis affecting the anterior portion of the cords, tuberculosis, the posterior, and that, in cases where the posterior portion was affected by syphilis, it was apt to be confined to one arytenoid, while in tuberculosis both are involved. These statements have no diagnostic importance attached to them, and would be misleading if followed. Malignant growths can usually be determined after repeated examination.

Lake rightly warns against diagnosing all affections of the larynx in tuberculous patients as tuberculous. He makes the surprising statement, however, and attributes much importance to it, that: "It is well known that in cases of tubercular laryngitis the physical signs of pulmonary phthisis become masked to an extraordinary extent. Dullness is frequently reduced, and in mild degrees of consolidation even abolished. The note over a cavity is at times apparently normal, and all adventitious sounds more or less masked; in fact, the physical signs are not uncommonly negative, or confined to a few moist sounds or to bronchial breathing. From this it will be evident that it takes a wide experience in the examination of the chest to estimate correctly the pulmonary condition in the class of cases under consideration." This statement I am unable to confirm. I can see no reason why it should be so, and would feel that errors would be committed if examiners should attempt to attribute diagnostic importance to the statement.

My experience will not confirm the oft repeated statement that the tuberculous infection is preceded by a paleness of the mucous membranes. If the infection takes place late in the disease after the patient has suffered from anemia, then the mucous membranes of the larynx will show the condition of paleness before infection occurs. If it occurs when the patient is in a robust physical condition, and not anemic, the mucous membranes will not be anemic prior to infection. A paleness is often seen after infiltration has been present for a time and prior to ulceration occurring; but such a thing as a ''pretuberculous paleness'' seems impossible and inconsistent with our knowledge of the methods of infection, the pathology, and the clinical course of tuberculous laryngitis.

The various laryngeal pictures can best be remembered after being seen.

Tuberculin is, at times, of value in clearing up doubt as to diagnosis. In order to utilize this test, the appearance of the larynx should be carefully observed for several days prior to the injection of the remedy. The diagnosis in this case depends upon the focal reaction, which is more uncertain than the cutaneous reaction. When tuberculin is brought in contact with the tissue cells of the skin a reaction will almost universally occur in strong individuals if active tuberculosis is present. This does not hold for the focal reaction when the tuberculin is injected into the tissues. The dosage required for a focal reaction varies greatly at different times; so, at one time a reaction might follow the injection of a given dose, while at another it might not. Repeated examinations, beginning from four to six hours after the injection, and continuing for twenty-four to thirty-six hours will usually find the reaction if it occurs. One examination on the day following might easily miss a reaction because of its having occurred sooner and having passed off; or because of its coming on later.

Treatment.—In considering the treatment of tuberculous laryngitis, the most important fact is to recognize that it is only a laryngeal localization of a tuberculous infection elsewhere in the body, usually in the lungs, and that it is not a distinct disease of itself. The treatment consists of that which is efficacious against tuberculosis in general. Whatever local measures are applied must only be expected to keep the process clean, and relieve cough and pain. The cure is that of tuberculosis in any other part of the body, and I would refer my readers to those chapters dealing with treatment in general for its discussion. Hygienic living, open air, adequate food, regulated rest and exercise, hydrotherapy, phototherapy, psychotherapy, and tuberculin, are the major measures to be employed. Many minor ones may be used, each of which will add something toward cure, but these are the important factors which will raise resisting power and furnish the specific stimulation necessary to bring about healing. Proper hygienic care of the upper air passages should always be used in conjunction with other measures.

Many local measures may be used at times to advantage. An alkaline spray such as one made after the following formula is pleasant, keeps the parts clean, and has slight anesthetic properties:

℞	Acid carbol		gr. xx-lx
	Glycerin		ʒ iii
	Sod. bicarb.		
	Sod. biborat.	āā	gr. xv
	Aq. dest. q. s. ad.		℥ iv

M.

Sig.: Use as a spray in the throat several times a day.

When ulceration is present I have found menthol in olive oil distinctly advantageous in relieving pain, particularly the dysphagia. I employ the following formula:

℞	Menthol	ʒ ss-i
	Ol. Oliv	℥ iii

M.

Sig.: Gargle the throat before meals, allowing the solution to remain in contact with the tissues for a few seconds.

In making up this formula care must be used in dissolving the menthol. This can be done by gently heating. The medicament should be allowed to run down in the larynx and come in contact with all painful and ulcerated surfaces. Some patients object to the taste of the olive oil, but, when they do not, this formula will prove to be a very valuable aid in relieving their pain. The influence of the menthol usually lasts long enough for the eating of a fair amount of food.

Inhalation of anesthesin according to the following formulas suggested by Lockard is often valuable.

℞	Anesthesini	ʒ v
	Mentholi	ʒ iv
	Ol. Olive	fl℥ iv

Or

℞	Anesthesini	gr. xlv
	Sp. vini. rect.	fl℥ iss
	Aq. dest.	fl℥ ii

Sig.: Inhale for ten minutes.

Orthoform is the old standard remedy which is relied on most. It may be blown into the larynx by a powder blower, or it may be employed as an emulsion made up fresh with the white of egg. When the cough is severe heroin may also be mixed with the powder to advantage. The following formula for using orthoform in emulsion has been recommended by Lockard:

℞	Menthol	1-15 parts
	Almond oil	30 parts
	Yolk of egg	25 parts
	Orthoform	12 parts
	Water to	100 parts

Cocaine which was formerly used so much in the treatment of tuberculous laryngitis is used very little now, especially by those who attempt to bring about healing instead of palliation. When persisted in, its use causes a general relaxation of the tissues and seems to make matters worse. Protargol in 10 per cent solutions and argyrol in 10 to 25 per cent solutions are of value. I have never found it necessary to use lactic acid, or any of the strong solutions so often recommended. Neither have I found it necessary to resort to operative measures. In fact, I disapprove of all such as being harmful and meddlesome. They do not meet the pathological conditions present. Strong antiseptics can be applied to the tuberculous ulcers indefinitely, but they do not cure the ulcer. Scraping and excision may be followed by relief for a time, but are usually followed by conditions worse than before. Conservative measures will prove satisfactory in so large a percentage of cases that they should be the main part of any line of treatment employed.

Rest to the larynx is valuable particularly when the cords are injured. I do not see the necessity, however, of compelling all cases of tuberculous laryngitis to whisper regardless of the location of the lesion. The judgment and common sense of the laryngologist should be used in employing rest, the same as other measures.

Tracheotomy has been advised and employed in order to relieve the larynx of all work. In several hundred cases which I have treated I have not used it, nor can I see any reason for using it, except in case of threatened suffocation, if the patient is properly guarded and treated.

Compresses to the larynx wet in cold or warm water and covered over snugly by dry bandages often prove very effectual in relieving the tendency to cough and in lessening pain. This often proves to be a specially valuable routine measure.

The efficacy of the treatment of tuberculous laryngitis can be greatly increased by the intelligent administration of tuberculin. This, combined with other measures, increases the percentage of cures above that produced by the general tonic measures alone, as can well be seen if one will observe the effect when properly administered. Like all other measures which require skill in their application the results are in proportion to the intelligence which guides its use. The principles of its use, as given in Chapter XL, should be followed.

There is a wide difference in the opinion usually held by laryngologists, and specialists in tuberculosis on the treatment of tuberculous laryngitis. The tuberculosis specialist has had most to do with establishing the fact that tuberculosis of the larynx will heal. This is due to two things; first, he makes his diagnosis earlier, and finding the disease as an early infiltration, he sees it heal; second, he is in a better position to care for the tuberculosis in general, a condition which is absolutely essential to the cure of the trouble in a large percentage of cases.

It must be remembered that tuberculosis of the larynx is only the localization of the general process and that its cure, like tuberculosis anywhere, depends on following a careful regime over a prolonged period of time, and in building up the patient and keeping his resisting power high.

The laryngologist, on the other hand, as a rule, sees, or at least, recognizes mostly ulcerative lesions, consequently he is dealing almost exclusively with end results instead of with early lesions. He is too apt to consider it from its local aspect instead of its general bearing. Further, from habit and training, he is prone to rely on local measures for its relief.

Lockard[8] takes a broader view than laryngologists as a rule. While he has great faith in local applications, at the same time he insists most strongly upon constitutional measures. He relies very largely upon the use of pigments such as lactic acid, in increasing strength ranging from 20 per cent to 100 per cent; but particularly on formalin, beginning with a strength of 3 per cent and gradually increasing to 10 per cent, applications being made every day or every other day. He further insists on rubbing this in with an applicator having a firm handle, so that considerable pressure may be exerted, believing that the value of the application depends on rubbing it into the tissues.

He has been disappointed in his results with tuberculin and believes it to have no effect beyond that which can be produced, or is produced by other measures. My experience is directly contrary to his in this particular. I have seen most excellent results follow the use of tuberculin, in conjunction with the use of general hygienic measures. Local applications, in my hands, have been confined to keeping the larynx clean by alkaline sprays, relieving pain or dysphagia, where possible, and using only such mild applications as protargol or argyrol.

This fact goes to show that men may arrive at the same result by different measures; and, further, that tolerance should be accorded to every man's opinion and respect accorded his work, providing a satisfactory result is obtained, whether it is accomplished according to one's individual ideas or not.

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[8] Tuberculosis of the Nose and Throat, C. V. Mosby Company, St. Louis, 1909.

CHAPTER XXIV.

TUBERCULOUS ENTERITIS.

Primary Intestinal Tuberculosis.—The question of primary intestinal infection received much discussion following Koch's announcement at the London Congress, that, owing to the fact that primary intestinal tuberculosis was so rare, ingestion tuberculosis was negligible, consequently bovine bacilli could not be a common source of infection in man.

We now know this reasoning to be false because bacilli will pass through the walls of the intestinal tract, without leaving a trace; and, when once through the mucous membrane they may either be carried to the mesenteric glands, or, what is more common, be carried with the chyle through the thoracic duct and poured directly into the circulating blood, according to the experiments detailed in Volume I, Chapter II. The fact of bacilli entering the body through this portal then, is the same as that of those entering by any other route.

As I have discussed elsewhere, surface infection occurs, as a rule, only as a metastatic infection after the cells have developed a specific defense. Prior to this time bacilli pass through the mucous membranes apparently unhindered and are carried directly to the lymphatic glands, consequently we find primary tuberculosis of the intestine as a very rare condition. Widerhofer found the mesenteric glands involved in 83 children; but, was unable to find, after careful search, a single infection of the intestinal wall in any of these. The frequency with which undoubted primary mesenteric gland tuberculosis is found may be inferred from the following statistics quoted by Fürst.[1] Bouvaird found primary lesions in 1.5 per cent, Still in 3.3 per cent, Carr in 4.2 per cent, Hof in 7.2 per cent, and Woodhead in 11 per cent of the total number of children examined by each. It would be likewise erroneous to consider that the percentage of infections of the mesenteric glands is any indication of the percentage of body infection through the intestinal tract, because the bacilli may be taken up by the lacteals, carried through the thoracic duct and poured into the blood stream to be strained out in the lungs; or, escaping this, to be carried to any part of the body. Neither is it necessary that the bacilli produce a frank clinical tuberculosis in the pulmonary tissue should they be strained out in them. They could, after gaining access to the lymph channels, be carried directly to the lymphatic glands which drain the area in which they become implanted. This may be the explanation of many of the primary foci described by Ghon in his remarkable work. When bacilli become implanted in the intestinal wall to form the primary infection, we must look upon it as more or less of an accident, because prior to the time that the body cells are sensitized and able to put up a specific defense it is the rule for bacilli to pass through those structures without hindrance; and, after the cells have developed specific cellular defense it must be exceedingly rare for sufficient bacilli to be ingested to overcome the defense of the cells and cause an infection, except as a result of swallowed sputum from ulcerative pulmonary lesions. On the other hand, when one considers that no matter how great the care used, patients suffering from open lesions swallow bacillus-bearing sputum daily and often in large quantities, the relatively greater danger to the patient from his own sputum, as compared with the danger from bacilli coming from without is quite clear. Consequently, primary intestinal lesions are extremely rare; and superinfection by way of the intestinal wall, with the source of inoculation outside of the body of the patient, must likewise be uncommon.

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[1] Die Intestinal Tuberkulose-Infection, Stuttgart, 1905.

The degree of danger to the intestine to which the patient suffering from open pulmonary tuberculosis is thus exposed, as compared to others, is not generally appreciated. A smear of the homogenized stool as detailed in Volume I, Chapter XX, when stained and examined after precautions were taken to rid the intestinal tract of bacilli showed bacilli in about 50 per cent of the advanced patients in the Pottenger Sanatorium.

Metastatic Tuberculosis of the Intestines.—Intestinal tuberculosis is nearly always secondary; and, like laryngeal tuberculosis, is nearly always secondary to infections in the lungs. Like laryngeal tuberculosis it is also a metastasis which is caused by surface infection: although blood metastases are also possible.

That it is an infection which takes place secondary to a focus elsewhere in the body may be inferred from the relationship which exists between it and the regional glands. Like metastatic pulmonary tuberculosis, and laryngeal tuberculosis, intestinal infection bears the same relationship to the regional lymph glands that a second inoculation of a previously infected guinea pig bears to the regional glands,—that is, the glands are not infected. The reaction between the bacilli at the point of inoculation and the local cells is such as to hold the bacilli captive and prevent their escape. The chief struggle for mastery has been transferred from the lymph and other protective elements with which the body is naturally endowed, to the tissue cells which are now endowed with specific defensive power. Not so in the case of the primary foci in the lung which have been described by Ghon. These infections being primary, occur in tissues which are not endowed with specific defense. The local cells at the point of implantation are not able to ward off the infection or hold it in check; so the protection of the lymph elements must be relied upon and the bacilli are accordingly carried from the point of inoculation to the regional lymphatic glands which enlarge and take part in the process. The same is true of infections in the glands of the mesentery as related to primary infection of or through the intestinal wall.

Factors Predisposing to Intestinal Infection.—The location of the lesions in infection of the gastrointestinal canal indicates that retardation and stagnation of the bowel contents is an important factor. That this should be true may be assumed from a comparison with the implantations of bacilli which occur in the lung and larynx. Bacilli require to be in contact with the tissues a certain amount of time in order to become implanted and produce infection; so we expect those parts of organs which show retardation of blood and lymph flow to become infected with greatest ease when the infection occurs through these channels. Thus, the apices of the lungs of adults are more prone to infection than the bases. When surface contact is the source of infection, conditions which retard the progress of the bacillus-bearing material favor infection. This is evident in the larynx and in the lower part of the ileum, the cecum, the ascending colon, the appendix, and the rectum.

The contents of the intestinal canal pass rapidly through the duodenum so that bacilli have little chance for implantation. It is in the lower portion of the ileum, the cecum, and ascending colon, those parts of the gut where retardation of contents occurs, that infection is common. The importance of retardation of contents as a factor in infection may be inferred from the localization in the colon as shown by the statistics of Fenwick and Dodwell, quoted by Maylard[2]. In 883 bodies examined postmortem some part of the intestine was ulcerated in 500 cases. The ascending colon was affected in 51.4 per cent, the transverse colon in 30.6 per cent; the descending colon in 21 per cent; and the sigmoid in 13.5 per cent.

The gradual progressive reduction in percentage of infections from cecum to sigmoid also bears a relationship to the absorptive properties of this canal, and this may be an important factor in what otherwise seems to be a more or less clear case of infection because of longer contact. It is at least well to bear in mind that the lower portion of the ileum, the cecum, and ascending colon have two points in common. Each represents the part of their respective portions of the canal where slowness of passage of contents and absorptive activity are most pronounced.

Not only do we have particular portions of the gut especially prone to infection because of the natural retardation of contents, but, as discussed in Volume I, Chapter X, there are many conditions in tuberculosis, which exaggerate stasis of the bowel contents; and these become more marked as the disease progresses and the pulmonary destruction increases.

It is also supposed that local irritations in the intestine, such as those produced by stasis, constipation, enteritis, and colitis, and such diseases as dysentery and typhoid which cause distinct lesions in the gut, are a direct predisposing factor in infection. Anything which will tend to aid the implantation of bacilli, whether by furnishing conditions in the intestinal wall which favor lodgment of bacilli, or which keep the bowel contents long in contact with the surface favor infection.

One striking feature in these infections is the fact that they are so prone to involve the solitary glands and follicles. It is probable that these lymphatic structures in discharge of their protective services to the organism, take up the bacilli in such quantities that they are not able to destroy them and consequently infection results.

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[2] Abdominal Tuberculosis, P. Blakiston's Son & Company, Philadelphia, 1908.

The fact that the general resistance of the patient gradually wanes as the disease advances and the toxemia becomes more marked, is probably also an important factor in the infection of the intestines, the same as it is elsewhere. We probably do not take into consideration sufficiently the effect of the trophic disturbances in favoring implantation. The nerves (both vagus and sympathetic) which supply the intestinal tract suffer a prolonged central stimulation from toxins produced by and as a result of the disease, as well as peripheral irritation by the inflammation in the lung, which must necessarily cause trophic changes in the cells of the intestinal wall, thus lowering their resistance to infection. The body defenses put up a long hard fight against the ever advancing tubercle bacilli; but in a large proportion of those who reach the open stage, unless they are given the most careful management, the fight is a gradually losing one. As the disease advances, the destructive process increases, complications take place, degenerations occur, the function of important organs is depressed and there is a gradual spreading of the disease beyond the confines of the lungs to other tissues and organs. While there is evidence of the spread of tuberculosis to such organs as the larynx and intestines in many cases in which the disease is not so far advanced, these organs are affected in two-thirds, or more, of those dying of the disease.

Pathological Changes.—As mentioned above, the lymphoid tissues are prone to infection and these are most abundant at the lower portion of the ileum, and the cecum. Pyer's patches offer a favorite seat for infection in tuberculosis, the same as in typhoid. A point of differentiation in these two forms of ulcers is the shape of the ulcer, that of typhoid running the long way of the intestine, while that of tuberculosis encircles it. The reason why the tuberculous ulcer encircles the gut is because after infection has once occurred, the metastases follow the lymphatics which run around, instead of lengthwise of the intestine.

Tubercles in the intestine follow the same changes that they do elsewhere. The process may result in the formation of new tissue, or in destruction of tissue. In the former case the gut thickens; in the latter there is necrosis and caseation with open ulcerations on the surface. There is considerable tendency to new tissue formation, even in the bases of the ulcers. As a result of this perforation rarely occurs. I have observed perforation of the intestine from a tuberculous ulcer in only one of my cases which I shall describe later (see page 661).

When the serous coat is involved in the tuberculous process, adhesions are prone to follow. These may take place between other portions of the intestines, the abdominal wall, or some of the other abdominal viscera.

At times there is a tendency for the ulcer to advance; pus forms, and, unless relieved, burrows in the direction of least resistance. This may take a course along adhesions, if present, and so find its way into distant places; it may be absorbed or it may rupture. When it ruptures it may be into the bowel, the abdominal cavity, or even externally. Sometimes lime salts are deposited in the abscess cavity, thus obliterating it.

Hemorrhage.—Regardless of the extensive ulceration that occurs now and then in the intestines, bleeding rarely occurs to any marked degree. The reason for this is the same as when the lungs are involved. The peculiar pathological process in tuberculosis tends to an obliteration of the vessels, and this nearly always takes place before the ulceration occurs.

Stricture.—Two types of stricture of the bowel are found in tuberculosis of the intestine. In one there is a general lymphatic process present. The walls of the intestine are thickened more or less uniformly and the lumen is sometimes reduced to a very small caliber. The other type is that which follows ulceration. The edges and bases of the ulcers thicken and these later contract, encroaching upon the lumen. These constrictions are, as a rule, several in number, depending on the number of ulcers. If the constriction is great, that portion of the intestine which is proximal to the obstruction dilates. In some of the patients observed by me the obstructions were numerous and only about six inches apart. In the case reported on page 650 this intervening portion was so distended that the intestinal wall was as thin as paper. This distention which results from both fecal contents and gas is a troublesome symptom. It is very painful at times. Complete obstruction rarely occurs. In the case just referred to the lumen of the gut at the point of constriction would barely admit of the entrance of a small pencil.

Symptoms of Tuberculous Enteritis.—Intestinal tuberculosis, either of the hypertrophic or ulcerative type may be extensive and yet unsuspected from the clinical symptoms. This is surprising because of the fact that the bowel contents are continuously passing through the lumen of the diseased intestine; and, in the ulcerative type, over the denuded surfaces. One would expect pathological conditions to be painful under such circumstances, but pain in the intestinal canal, except as elicited on pressure, seems to result only from distention of the circular fibers of the gut; consequently it is only present when the lumen is constricted by spastic contractures, or strictures due to pathological thickenings and, as a result of such contractions distention occurs above the point of stricture. I have been greatly surprised at times to find at operation on the abdomen of tuberculous patients, or at the postmortem table, a widespread tuberculous enteritis which had shown no previous evidence of its presence. Although I have carefully observed many patients during the time that the bowel was becoming infected and many during the time that an infection existed, yet I am compelled to say that I know of no symptom or group of symptoms upon which we may positively base a diagnosis.

Variable Appetite, Disgust for Food, and Nausea.—These have been the first symptoms that I have noticed in some patients, but these are present in so many other conditions that they are not diagnostic. The patients are apt to complain of the food. They think that if they could only have a change in diet they would gain; but such a change satisfies only temporarily.

Effect on Nutrition.—Disturbances in nutrition are brought about both by the lesion influencing the secretion and motility of the gastrointestinal tract, and by interfering with its absorptive power. As a result of this there is usually difficulty in keeping the patient nourished. A patient who has been gaining ceases to gain, or loses weight. The loss, as a rule, is slow, but continuous. In other cases the weight will remain stationary regardless of the consumption of large quantities of food.

The symptoms vary according to the nature, the location, and the severity of the lesion and according to whether there is only one, or a few, or many foci.

Pain.—This is a very uncertain symptom in tuberculosis of the intestine. I have seen severe widespread disease with no more pain than that which accompanies an ordinary case of colitis of moderate severity. Frequently, the pain when present, is colicky in nature, the same as it is in colitis; again, it is a soreness; and, at times, it is only experienced on pressure. It is frequently noted in the right iliac region, particularly when the appendix and cecum are involved; and, again, it is centered about the umbilicus. Less frequently it is complained of in other parts of the abdomen. Unfortunately, there is nothing distinctive in its character by which it may be distinguished from other pains.

When the rectum is the seat of tuberculous ulcers, there is often pain low down over the abdomen, but the most characteristic pain is the tenesmus associated with frequent bowel movements.

The referred pain may be found in the skin, muscles or connective tissue which receive their innervation from the same segments of the spinal cord (sixth to twelfth), which receive the afferent stimuli which pass from the intestinal tract through the splanchnics. Thus, the pain may appear in the right iliac region, as it does when the appendix and cecum are involved. Again, it may be centered about the umbilicus; or, at times, may be found over other parts of the abdominal wall. Pain due to tuberculous enteritis is the same as pain due to any other inflammatory condition of the intestines, consequently there is nothing distinctive in its character.

Change in Motility.—It has been shown by Walter C. Alvarez[3] that an irritation in the gastrointestinal tract checks motility in the proximal portion of the gut and increases it in the distal. So we can see that tuberculous ulcers should exert a markedly disturbing influence on motility. We can see that this, too, should be of a double nature, sometimes checking the movements of the bowel contents and again hastening it; which corresponds with our clinical observations. We sometimes find a constipation in the face of severe ulceration as determined by operation or postmortem; again we find diarrhea. Sometimes alternating constipation and diarrhea are found. There is nothing pathognomonic, however, in the way that tuberculous ulceration affects motility. The x-ray findings in diagnosis are given in Vol. I, page 532.

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[3] The Motor Functions of the Intestine from a New Point of View, Journal American Medical Association, July 31, 1915, vol. lxv, No. 5.

Stool.—There are no regular departures from the normal to be observed in the stool. At times there is a peculiar disagreeable odor, which seems to be different from that in simple colitis. It is probably due to the admixture of partially digested and poorly absorbed food material, which has been hastened onward and discharged from the intestinal canal. Sometimes blood is found mixed with the stool. Mucus is commonly present.

One characteristic which increases my suspicions in cases of suspected tuberculosis of the intestine is night stools. In simple enterocolitis the bowels usually move during the morning hours, the patient probably having two or three movements in the forenoon. In tuberculous diarrhea, on the other hand, the motility seems to be increased to a greater extent, so the food which was eaten early in the day is discharged from the bowel during the night; then the movements continue during the day. The consistency may be that of a normally formed stool, or it may be mushy, or watery.

Bacilli in the Stool.—The finding of bacilli in the stool was formerly thought to be of great value; but now this is known to have no bearing at all on diagnosis, because bacilli are present in the feces of practically all patients who have bacilli in the sputum. For the past ten years, in the Pottenger Sanatorium, we have disregarded their presence as being evidence of bowel infection. During the years 1906-1908, Doctor J. E. Pottenger examined the stools of all patients entering the sanatorium in order to find how commonly bacilli are present, even when precautions are taken to avoid swallowing the sputum. The following routine was employed. On entering the institution the patient was given a dose of castor oil. Instructions were then given to exercise extreme care not to swallow the sputum because of the danger of infecting the intestinal tract. After care had been exercised for one week a stool was taken for examination. The stool was prepared in the most simple manner possible. It was shaken in the shaking machine, and then a smear was made from the homogenized mass. To our great astonishment we found bacilli present in about 50 per cent of our advanced cases, as shown in Volume I, Chapter XX.

This demonstrates not only the fact that bacilli in the stool are not evidence of tuberculous involvement in the intestines, but also offers definite proof of the high specific resisting power that the body cells develop against bacilli in the presence of an infection. Bacilli when once cast off from the ulcerating surfaces in the lung may produce surface infection in the bronchi, trachea, and larynx, or be swallowed and produce the same surface infections in the intestinal tract; but, if we may judge from the fact that the lymph nodes which drain the areas involved are rarely infected, we are justified in assuming that all of this surface infection must be looked upon as being a result of massive inoculation and as taking place after a weakening of the defense of the cells at the point of implantation has occurred. It is proof that both the general and specific defensive powers of the cells have, for the time being, been overcome.

Temperature.—The temperature in tuberculosis of the intestines shows the same characteristics as that of tuberculosis elsewhere. The course may be afebrile during quiescence, slightly elevated with constant inflammation, and more markedly elevated when a tuberculous ulcer is forming. I have often thought that the temperature assumes a slight increase in diurnal variation when the bowel is involved; but this is not constant, neither is it peculiar to this infection. The type that I refer to is shown in the charts accompanying Cases 2383 and 2161, pages 631 and 650.

Pulse.—At times, when the bowel is involved, we note a more or less marked disproportion between the pulse rate and the temperature, suggesting an increase in the inhibiting action of the vagus. I suspect bowel involvement as the cause of this if the case is one of advanced tuberculosis with temperature. I would particularly suspect this if the patient does not naturally show other signs of increased vagus tone. As shown in Vol. I, Chapter VII, however, this cannot be distinctive. A relative slowing of the pulse is frequently found during the course of pulmonary tuberculosis as a result of stimulation of the pulmonary

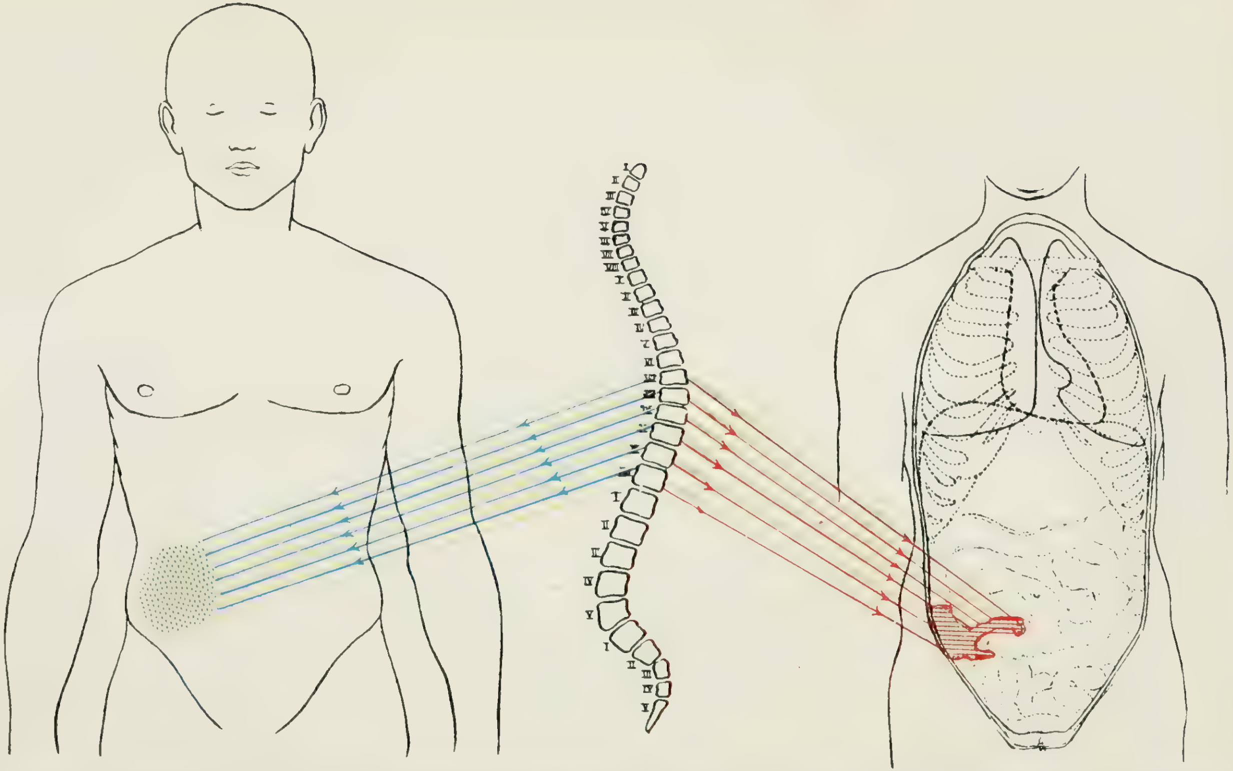

Plate VII.—Representing the Path of the Motor and Sensory Reflexes in the Presence of Tuberculosis of the Intestines.

The *red lines* running from the lower six thoracic segments represent the sympathetic innervation of the intestines. The *green lines* running from the intestines to the same segments (VII to XII thoracic), represent the sensory sympathetics carrying the impulses from the inflamed intestines to the cord. The *yellow lines* running from the same segments of the cord (VII to XII thoracic), represent the spinal motor nerves which complete the reflex by transmitting the impulses to the musculature of the lower right quadrant of the abdomen. The *blue lines* represent the spinal sensory nerves which complete the reflex by causing disturbed cutaneous sensation over the right lower quadrant of the abdomen. The *arrows* indicate the direction in which impulses travel.

filaments of the vagus even during fever, as shown in Fig. 31, Vol. I, page 203. The result of stimulation of the depressor nerve in intestinal inflammations has long been known in non-tuberculous involvements. I have noted this same thing and have found it to add confirmatory evidence when intestinal tuberculosis is suspected from other symptoms, as shown in Fig. 163, page 649.

Muscle Reflex.—It is probable that all inflammatory processes affecting the internal viscera cause reflex phenomena which are expressed in the superficial soft tissues through afferent sympathetic neurons connecting with sensory and motor nerves in the segments of the spinal cord. Could we but determine these changes we would be possessed of valuable aids in diagnosis. We are conversant with both the motor and sensory reflexes in appendicitis, diseases of the gall bladder, and ulcer of the stomach and duodenum; but there is no reason for not suspecting the same phenomena when other portions of the gastrointestinal tract are inflamed, as in tuberculosis.

These reflex sensory and motor phenomena are expressed in those structures which are supplied by nerves which are in reflex communication with the sympathetic nerves which supply the intestines. This relation is shown in Plate VII, in which it is seen that the intestines are supplied by the nerves, splanchnicus major arising from the fifth, sixth, seventh, eighth and ninth thoracic ganglia, and splanchnicus minor arising from the tenth, eleventh and twelfth thoracic ganglia. Through these ganglia, the splanchnics communicate with the corresponding segments of the cord from which arise the muscles obliquus, transversalis, and rectus abdominis,—coming from the seventh to twelfth thoracic segments; and with the sensory nerves which supply the marginal portion of the diaphragm, the peritoneum of the anterior abdominal wall, and the skin over the abdominal wall. The motor reflex rarely shows in the lower intercostals.

In many cases I have determined the viscero-motor reflex in the right abdominal wall when tuberculous ulceration was present in the lower ileum, appendix, cecum, or ascending colon, as proved later by operation or postmortem.

This increased muscle tone, which has proved so valuable in the diagnosis of simple appendicitis, should be valuable in tuberculosis of the intestines. This is particularly true in patients who are in good physical condition with normal abdominal muscles. If, however, this infection should be established later, after degeneration of the muscles has occurred as a result of the disease, then increased muscle tonus would be extremely difficult to determine with any degree of certainty.

Treatment of Tuberculous Enteritis.—Primarily, the treatment of tuberculous enteritis is that of tuberculosis in general. Tuberculosis of the intestine is usually thought to be a fatal complication; but this is not necessarily true. While there is no doubt that many implantations occur which heal without the process extending, and without ulceration taking place, and even scars at the site of previous ulceration are now and then found postmortem, the difficulty which attends the healing of a severe widespread infection in the intestinal wall, particularly after ulceration has occurred, is evident. The surface of the ulcers is constantly bathed in irritating mixtures of digestive juices and food in various stages of digestion, which probably produce more or less maceration of the tissues.

When the diagnosis of tuberculosis of the intestinal canal has been made, the first thing to decide is whether or not there is hope of removing the infected area by operative measures; and, second, whether or not the patient is able to undergo the operation, if otherwise thought advisable. It should also be considered whether, if successfully removed, the patient's general condition is such that recovery or sufficient improvement may be obtained to warrant the operative interference.

In my experience there have been comparatively few cases which would meet the conditions just mentioned. As a rule a marked lesion, one with widespread and severe ulceration, is present before the symptoms are sufficiently marked to cause suspicion of the true nature of the trouble; and, further, the patient is usually well advanced in a serious ulcerative pulmonary involvement and quite often with continuous temperature indicative of marked toxemia when the infection occurs.

Until we obtain better methods of diagnosing tuberculosis of the bowel so that we are able to detect it early, we cannot hope for great things even in the cases which would be otherwise operable.

When the infection is confined to the appendix, or the adjoining tissue either in the ileum or cecum, operative procedure may be entirely satisfactory. The removal of the parts relieves the symptoms dependent upon the lesion, and when the infection is not beyond the parts removed, results in cure. Unfortunately, it does not prevent further infection from the same source. In most of the cases that I have operated, unfortunately, there has been, at the time of the operation, or later, further infections in other parts of the canal, which made the benefit more or less temporary.

If we are to hope for a cure to result the infection must be localized and there must be such an improvement result from the operation, or, because of it and other tonic and hygienic measures employed, as greatly to increase the fighting powers of the patient and raise his resistance to the enemy's attack.

It is the chronic hyperplastic type which offers the greatest relief from surgical measures. This type may be inferred from the colicky pains which attend the distention of the gut which occurs above the point of constriction, together with the thickened walls felt on palpation. Colicky pains, without the presence of thickened walls are apt to be caused by spastic contractions of the circular coat provoked by irritation within the canal rather than by mechanical obstruction, and should be relieved without surgical measures. The hyperplastic type may be accompanied by diarrhea, constipation, or normal stool. Often mixed types are present, a hyperplastic condition in one area and ulcerative in another.

Operation may consist in either the removal of the area by excision, or excluding it from the canal by doing a short circuiting operation.

The cases which cannot be successfully operated, which will comprise by far the greatest number of patients, require careful management. While many of these, in fact nearly all of them, will fail in securing a healing, yet most of them can be relieved and made comfortable during the greater portion of their remaining days.

The first rule that I would lay down in treating these patients is to shield the intestinal tract from harsh and irritating measures. Strong cathartics should always be avoided. On several occasions in my earlier practice when I was inclined to use calomel rather freely in the treatment of the acute gastrointestinal attacks which accompany tuberculosis, I saw a diarrhea precipitated by the resulting irritation which proved to be the beginning of an intractible diarrhea due to tuberculous infection. While it is probable that the diarrhea would have manifested itself soon had the calomel not been administered, yet it forcibly called my attention to the advisability of avoiding all irritating measures when tuberculosis of the intestine is suspected.

The diet should be carefully regulated. It must be nutritious; for it is upon the ability to maintain nutrition that the result will eventually turn. If constipation is present such laxative foods as oatmeal, honey, prunes, fruit sauces and jellies may often be found sufficient to overcome it. If not, paraffin oil may be added and the bowels opened by an enema when necessary. Contrary to the usual opinion, constipation, either alone or alternating with diarrhea, is found very commonly as an accompaniment of this complication.

The diarrhea caused by tuberculous ulcers in the intestinal wall is extremely difficult to control by diet alone and often even by diet reinforced by other measures. The diet, however, should be suited to the condition present, bearing in mind that an adequate amount of food must be taken if progress is to be made. It is advisable to eliminate fruits, most sweets and the coarser foods which contain large quantities of cellulose for these stimulate peristalsis. If attention is given to the selection of foods, a liberal diet may be devised containing sufficient variety to avoid tiring and yet made up wholly of bland foods. Meat extracts are stimulating to peristalsis, likewise red meat itself; and, at times, must be limited in amount or withheld. The use of gruels which are valuable in simple diarrhea, rarely prove efficacious in checking diarrhea due to tuberculosis. In many instances it will be found that the patient becomes so tired of a limited diet that other articles of food must be added, even although it be known that they are not favorable to the condition present.

Next in importance to diet in treating the diarrhea of tuberculous origin, is rest. Patients suffering from diarrhea of any kind are aided by rest. Exercise stimulates peristalsis.

Hot applications to the abdomen are beneficial. Moist heat is preferable to dry heat. It may be applied in the form of hot packs for one or two hours both morning and evening. The cloths should be kept hot. This can be done by changing them every twenty minutes or by placing a water bottle filled with hot water over them. In either case the packs should be well covered by dry cloths to make the pack most effective. Dry heat dries the skin and interferes with its activity and also seems to be less active in its relaxing effect.

Bland enemas, used quite warm, containing starch water and bismuth, as described in Volume I, page 265, are at times valuable. Enemas containing nitrate of silver may at times be used effectively.

Remedies *per os* are often of value. They sometimes render considerable aid in the cases of least severity. In the severe cases, on the other hand, all remedies will disappoint. The two classes of remedies which are especially valuable are antispasmodics and astringents. Atropin has a very important action in relaxing spasm and relieving colicky pains, but must be used in such doses as to avoid the disagreeable drying effect upon the mucous membranes of the upper air passage and mouth. For an astringent effect, I, as a rule, rely on subnitrate of bismuth in the earlier stages and in the cases of least severity. It may be used suspended in water in doses of from 10 to 30 grains, repeated every two or three hours. Sometimes one or two large doses of sixty grains administered in the early morning, or both in the morning and evening will be better. Subgallate of bismuth with calcium salts may at times be relied upon according to the following formula:

℞ Bismuthi subgallat gr. viiss-xii
Calci phosphat
Calci carbonat q.s. ad. āā ʒ i
M. ft. pulv. No. I.
Sig.: Dispense No. xxx. Give one such powder every three or four hours.

For convenience this can be made up in bulk and a teaspoonful given at each dose.

Some form of opium will usually have to be resorted to sooner or later. The deodorized tincture is usually borne well. It is not as prone to induce nausea as some other preparations. I often add from ten to fifteen drops of the deodorized tincture to the aqueous mixture of subnitrate of bismuth above mentioned, thus:

℞	Tr. opi deodorat	ʒ iss-℥ i
	Bismuthi subnitrat	ʒ v - ℥ i
	Aq. dest. q.s. ad.	℥ iv

M.

Sig.: One teaspoonful every three to six hours after shaking.

Sometimes plain morphine in doses of $\frac{1}{8}$ grain several times a day, seems best. The lead and opium pill must not be forgotten. It may be given at bedtimes, or both morning and evening. Oftentimes the use of some astringent with or without some form of opium, given at night, will prevent the night movements which are so common and disturbing.

CHAPTER XXV.

TUBERCULOUS PLEURITIS.

Under the head of tuberculous pleuritis I desire not only to discuss such infections of the pleura as complicate cases of well developed pulmonary tuberculosis, but also those cases which precede the definite diagnosis of pulmonary tuberculosis, oftentimes months and sometimes years. It is extremely important that the true significance of these early pleurisies be recognized, and that the patient be given the opportunity for cure while the lesion is small and before it seriously affects more important structures.

Pleurisy Which Precedes Definite Clinical Pulmonary Tuberculosis.—In taking clinical histories in cases of pulmonary tuberculosis every careful clinician must be impressed with the frequency with which pleurisy was present months or even years preceding the recognized outbreak of the disease in the lung. In many cases the diagnosis ''intercostal neuralgia'' was made. In my experience, intercostal neuralgia is a much rarer condition than pleurisy; and, when present, is usually the result of a previous pleural affection; but, in medical practice the diagnosis is made with great frequency, and usually upon evidence of the most meager sort. Pain in the chest is usually sufficient to warrant such a diagnosis. The frequency of tuberculous pleurisy in adults and its importance as an early sign, a forerunner, so to speak, of serious pulmonary tuberculosis, makes this error one attended by singular gravity.

This type of acute tuberculous pleurisy usually affects the lower half of the pleura; not that this is the most frequent site of pleural tuberculosis, but that it is in the lower part of the pleura where the chief symptom, pain, is produced. A tuberculous pleurisy at the apex may cause no recognizable pain on account of the relatively small amount of motion; but, when the disease affects the lower portion, the greater respiratory movement causes pain by which the patient's attention is drawn to the part. We must look upon this early type of pleurisy as being a metastatic infection, in which the bacilli are carried to the pulmonary parenchyma near the pleura probably through the blood, or, it may be, the lymph; but, instead of becoming implanted deep in the pulmonary tissues, they make their way with the lymph toward the periphery and become enmeshed in the subpleural tissues. In this they follow the same course as the soot particles in the lung of city dwellers or the india ink in such experiments as those detailed by Schultze in Volume I, page 72.

In order to account for the hematogenous infections of the subpleural tissues it is necessary to assume that the bacilli are deposited near the periphery of the lung in that portion which drains toward the pleura instead of the hilus. And, in case the infection occurs in an individual whose body has previously harbored an infection and whose cells, as a result of it, are endowed with specific defense, we must further assume that the bacilli were screened out in the subpleural tissues themselves, for we cannot conceive of bacilli traveling far in the tissues after specific cellular defense has been established; for a specific inflammation is at once set up between the cells and the bacilli, which causes them to be localized at the site of implantation. It must also be evident that a direct implantation in the pleura or subpleural tissue might occur through the blood in the same manner as metastatic infection occurs in such organs and structures as the meninges, bones, joints and kidneys.

Such pleural infections are not, as a rule, due to extensions from foci in the underlying pulmonary tissue, if we except those which affect the subpleural tissues; but, to independent metastases which come from distant foci. Later in the disease, however, we have many pleural lesions which are secondary to an acutely inflamed pulmonary process which, while more or less distant from the surface of the lung, extend with their inflammatory process to the pleura.

These early pleural infections are just as much tuberculosis as the infections in the lung, bones, joints, or meninges; and they should receive due consideration at the hands of clinicians. Their presence is evidence of metastatic tuberculosis, and shows that a primary focus exists somewhere in the body which is not healed, but which is giving off bacilli to be carried to other parts. This fact is of greater importance to the patient and clinician than the discovery of the pleural involvement itself. This early tuberculous pleurisy is usually a benign infection. In this respect it resembles tuberculosis of the lymphatic glands. But the knowledge which the presence of the tuberculous pleurisy gives is a significant one in that it indicates the presence of a focus which is giving off bacilli into the blood stream; one which is likely to infect other organs, unless measures are taken to cause its encapsulation.

Too much emphasis cannot be laid upon the importance of treating all tuberculous lesions with the seriousness which they deserve until they are healed. Experience shows that the type of tuberculosis (tuberculous pleurisy) under discussion deserves the same consideration as though it were deep in the lung; not that it is as serious as the pulmonary form, where a considerable area of the parenchyma is involved, but because it is a signal of danger, being evidence of the fact that an active process exists in the body which is capable of scattering further infection.

If a focus of pyogenic infection were found in the tonsil, or at the roots of the teeth, or in the gall bladder, appendix, or any removable portion of the anatomy, it would be considered bad judgment not to remove it. If evidence of syphilis were found anywhere in the body, a failure to treat it seriously would be condemned. An open focus of tuberculosis is as serious as a focal infection of any of these and more serious than most of them, and demands intelligent treatment if cure is to be expected and the future welfare of the patient is to be conserved.

This type of tuberculous pleurisy should, without any further signs, or symptoms, make the diagnosis of active tuberculosis definite.

This early pleurisy may be accompanied by effusion, or it may be a dry process. The frequency of tuberculosis as the etiological factor in pleurisies accompanied by effusion is generally recognized; but not so with the so-called dry pleurisies. Lord,[1] in speaking of the relationship of the tubercle bacillus to pleural effusion, states that it has been demonstrated in from 22 to 85 per cent. In many instances where the bacillus is not found it is nevertheless the etiological factor. A failure to find bacilli in exudate, either by staining or by animal inoculation, should be taken only as negative evidence. The dry pleurisy, as mentioned above, is usually wrongly diagnosed as intercostal neuralgia, and its connection with a tuberculous infection is not recognized until much later when frank symptoms of clinical pulmonary tuberculosis manifest themselves. Not all of these early pleurisies, even though they are of tuberculous origin, are followed later by frank pulmonary tuberculosis. As in other structures, so here, tuberculosis often heals, and the focus from which the metastases came may heal at the same time, producing no further metastases in the body. But it is poor judgment on the part of the medical attendant to trust to such luck. It is his duty to give his patient, who trusts his life to him, the benefit of modern knowledge of such lesions.

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[1] Diseases of the Bronchi, Lungs and Pleura, Lea & Febiger, Philadelphia, 1915.

Pleurisy Which Complicates Pulmonary Tuberculosis.—Pleurisy is a very common, in fact, an almost universal complication of clinical pulmonary tuberculosis. Rarely do we find a tuberculous infection in the lung which has extended to such a degree as to produce symptoms in which we do not find some pleural irritation.

This fact is known to both pathologist and clinician and yet it is not fully appreciated. This is because the most common seat of pleurisy is over the apices above the third rib, where the tuberculous involvement is most common. Coming on here, where the respiratory movements are so restricted, pain, which is supposed to be the cardinal symptom of pleurisy, does not appear; and so the infection goes unrecognized. When the pleura, covering the lower portion of the lungs, becomes involved, however, pain becomes a prominent symptom.

Dry, adhesive pleurisy is far more common than pleurisy with effusion. The effusion usually collects at the base of the pleural cavity, no matter where the inflammation causing it is situated. We, however, at times, meet collections of fluid in the interlobular spaces and, extremely rarely, find them confined by pleural adhesions causing the so-called sacculated pleurisy.

Some writers claim that dry pleurisy is a misnomer and that all pleurisies are accompanied by some exudation; but that in the dry variety the amount is so small that it does not collect and become discernible. It absorbs as fast as it is formed.

The absorptive power of the pleura is marked and it is surprising what quantities of fluid it can take up in a short time. James[2] quotes the experiments of Dychkowsky which were made in 1866[3] and which show that both fluids and small solid particles can be absorbed by the pleura. Fluids, he states, are absorbed by filtration and osmosis and take place through all the surrounding structures—costal, diaphragmatic, mediastinal and pulmonary pleuræ—into the underlying blood vessels and lymphatics.

The Berlin blue used in his experiments was absorbed only through stomata in the intercostal spaces of the costal pleura. He also showed that the movement of the chest wall was an important factor in absorption. He also showed experimentally that when the trachea of the experimental animal was connected with an air space in which air pressure was lowered, that absorption was favored. Thus, the rarefied air at high altitudes should favor absorption, so should the chamber of the pneumatic cabinet when the air is rarefied. Exercise and deep breathing also should be aids in hastening absorption; yet they should be prescribed only after considering all other factors present.

The symptoms of pleurisy vary with the form and location. Apical pleurisy may result in no recognizable symptoms, even though thickening and adhesions have occurred; yet patients who have this condition complain more or less of vague pain, rarely sharp in character, but more often dull and aching; and later this often seems to resemble a compressing force.

At times marked thickening of the pleura may be found postmortem, even when the patient has failed to complain during life. Such cases, as a rule, are those which follow a gradually descending pulmonary involvement.

Acute Fibrinous Pleurisy.—Acute fibrinous pleurisy is usually a dry process. As it complicates tuberculosis it is usually accompanied by a slight rise in temperature varying according to the severity of the case from a few tenths of a degree to two or three degrees. It must be remembered that this form of pleurisy often shows in patients who are also running a temperature above normal and so only shows as an elevation of the regular curve. Such elevations of temperature usually last less than a week, although they may last many weeks. The elevation comes on gradually, taking two or three days to reach its maximum, and a like period to decline.

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[2] Pleurisy, William Wood & Company, 1911.
[3] Über Aufsaugung und Absonderung der Pleurawand, Ludwig's Arbeiten, 1886.

Pain is usually a prominent symptom. It may be sharp and cutting or dull and nagging. If sharp it is felt most commonly in the lower mammary and axillary regions. In many instances the pain is so severe that it can hardly be endured and causes great fear and anxiety on the part of the patient. Cough, the inspiratory effort, laughter, sneezing, and occasionally bodily movement may all cause the pain. The patient usually fears to take a long breath or to cough, consequently the breathing takes upon itself a short panting character when pain is very severe. Seasonal and meteorological influences seem to be a factor in the recurrence of pleural pain. Such conditions as favor so-called rheumatic pains seem to cause uneasiness and, at times, distinct pains in pleuræ, which have previously been the seat of inflammation. In Southern California we note pleural pain very often during the change from dry to wet when a rain storm is approaching, or from cool to warm weather; also during electrical storms when the atmosphere is particularly dry.

Cough is usually a symptom when the pleura is involved. If already present, as is so often the case in advanced tuberculosis, it is usually increased during the attack of pleurisy.

A friction rub can often be detected upon palpating during the early stage of the infection; although a marked inflammation can be present without its presence. When it cannot be felt it can often be heard through the stethoscope.

After the acute signs have disappeared we often find a rough grating, which remains for a long period of time. Râles which may be due to either pleural adhesions or to a disease process within the underlying lung, are often present at the time of the acute process and may become permanent.

Acute Serofibrinous Pleurisy.—Acute serofibrinous pleurisy complicating pulmonary tuberculosis is not so common as the fibrinous type. It usually comes on gradually. Serofibrinous

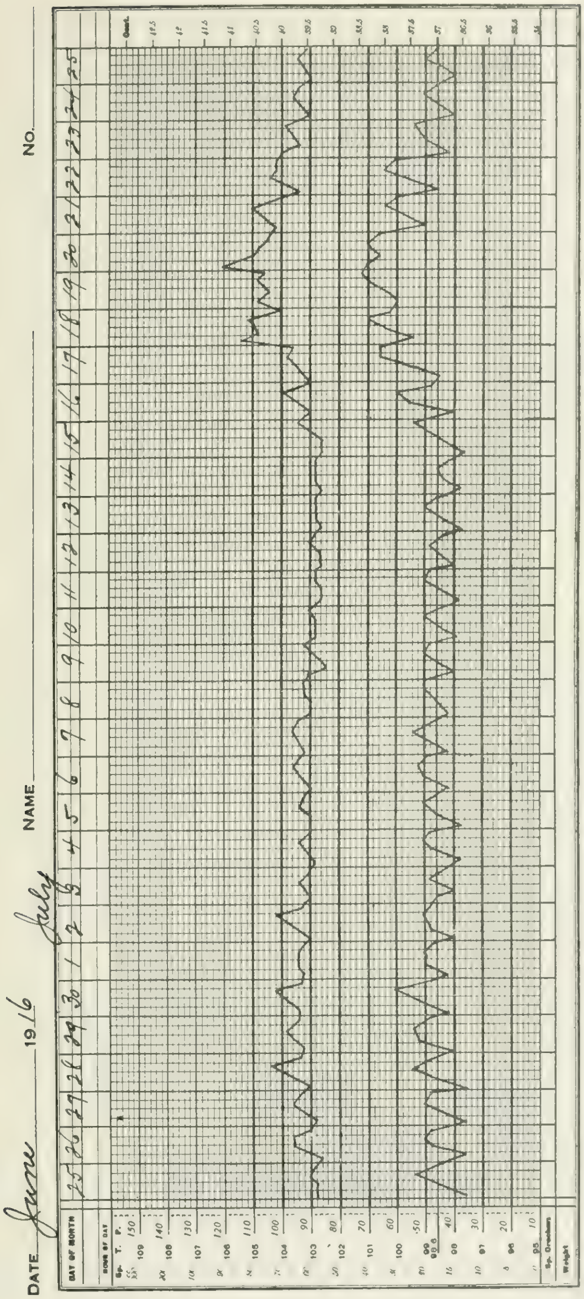

Fig. 16.—Showing the temperature and pulse curve of acute serofibrinous pleurisy in the course of chronic pulmonary tuberculosis. Upper curve, pulse; lower curve, temperature.

pleurisy is usually considered as being much more common in early manifestations of tuberculosis than as a complication of the pulmonary form of the disease. I have no doubt that this difference is exaggerated because of a failure to find the disease in the lung when the involvement is small. The after history of patients with serofibrinous pleurisy shows the development of pulmonary tuberculosis in from thirty to forty per cent of the cases.

Symptoms.—Some rise of temperature is usually found if measured with sufficient accuracy; but, at times, the first evidence pointing to the pleurisy is the change found on examination of the patient. The temperature, as a rule, is not high, not over 101° or 102° in adults, although in children it may go to 104°. The chart shown in Fig. 106 illustrates a common type of temperature found in pleurisy complicating pulmonary tuberculosis.

Pain may be present at the onset, but it disappears as the effusion separates the inflamed surfaces. If the effusion is large, dyspnea develops as the effusion accumulates. This, with cessation of pain, is sufficient to warrant a probable diagnosis of effusion. The pain at times is excruciating and at other times insignificant.

The particular localization of the pain of diaphragmatic pleurisy must not be forgotten. It often extends down over the upper abdomen and, when it does it is usually confused with inflammations in this region. Not infrequently is the abdomen opened, when the seat of the trouble is above the diaphragm. The common innervation of the costal portion of the diaphragm and the upper abdominal muscles by the lower six thoracic nerves, explains this. A pain is also often noted in the shoulders in the area supplied by the third and fourth cervical nerves. This double location of pain in diaphragmatic pleurisy depends upon its double innervation. In the period of development the diaphragm starts up in the region of the cervical segments and its central portion is innervated through the phrenics which come from the third and fourth or fourth and fifth cervical segments. Afferent impulses are carried through the phrenics and expressed as shoulder pains in diaphragmatic pleurisy. Plate VIII illustrates the paths of the impulses in producing reflex pain and muscle contraction in diaphragmatic pleurisy where the

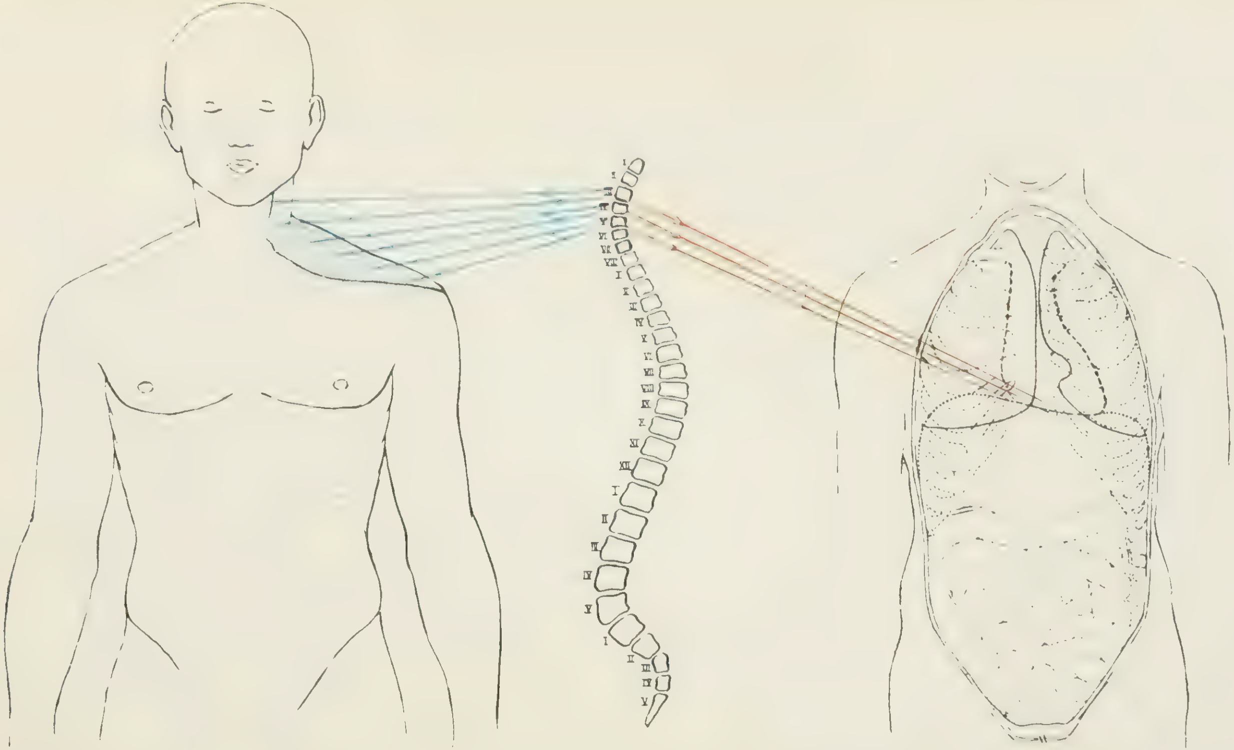

PLATE VIII.—SHOWING SCHEMATICALLY THE PATH OF THE SENSORY IMPULSES WHEN THE CENTRAL TENDON OF THE DIAPHRAGM IS INFLAMED

The *red lines* running from the IIId, IVth, and Vth cervical segments of the cord represent the phrenic nerves which innervate the central tendon of the diaphragm. The *green lines* represent the sensory impulses carried through the phrenic nerves to the same segments of the cord (IIId, IVth, and Vth cervical). The *blue lines* represent the spinal sensory nerves completing the reflex by carrying sensory impulses and causing altered sensation (pain) in the area of the IIId and IVth cervical sensory zones which are shaded in the figure. The *arrows* indicate the direction in which impulses travel.

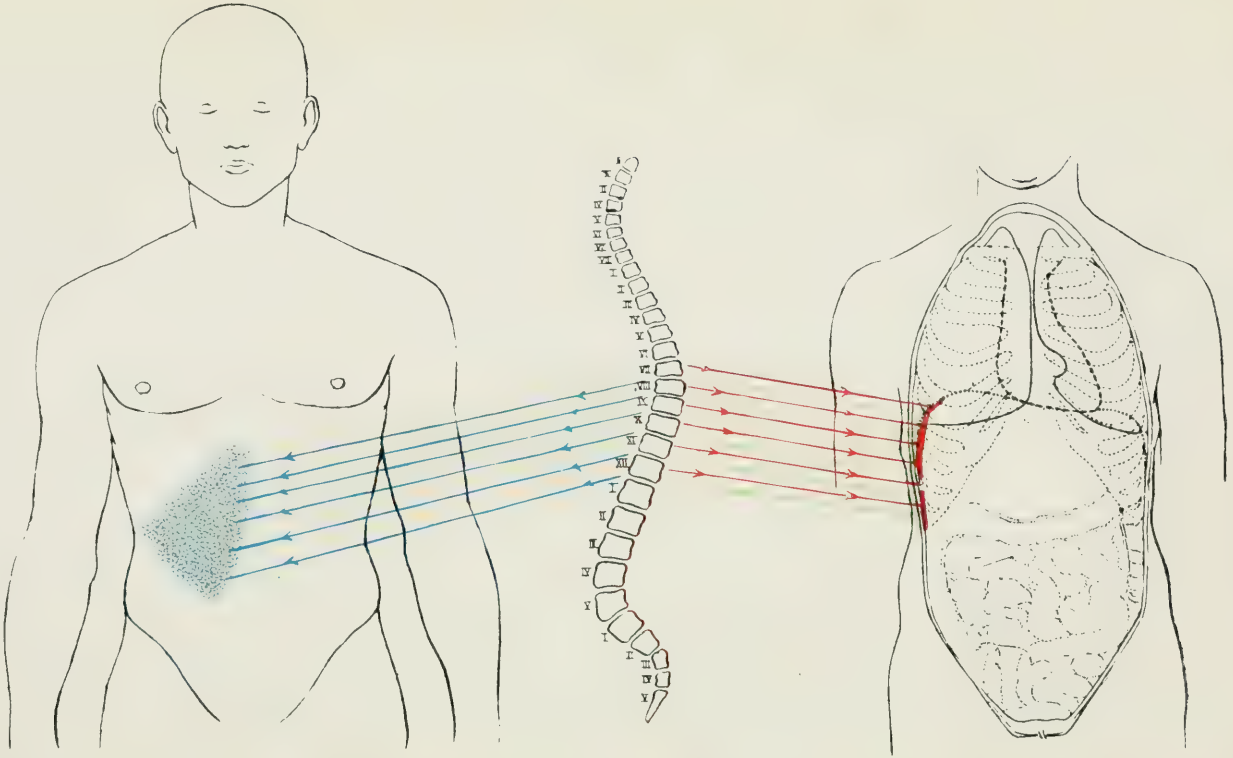

PLATE IX.—SHOWING SCHEMATICALLY THE PATHS OF THE REFLEXES WHICH PRODUCE THE SPASM OF THE ABDOMINAL MUSCLES AND ALTERED CUTANEOUS SENSATION OVER THEM (PAIN) IN THE PRESENCE OF INFLAMMATION OF THE COSTAL PORTION OF THE PLEURA.

The *red lines* represent the sympathetic nerves which run from the lower six (VII to XII) dorsal segments of the cord, and supply the costal pleura. The *green lines* represent the sensory impulses carried by the sympathetics to the same dorsal segments (VII to XII) when the costal pleura is inflamed. The *yellow lines* represent the spinal motor nerves which complete the reflex, carrying the impulse to the abdominal musculature on the same side of the body (the intercostals are also in spasm but this is not shown in cut). The *blue lines* represent the spinal sensory nerves which complete the reflex and produce altered cutaneous sensation (pain) on the side of the body where the costal pleura is inflamed. The *arrows* indicate the direction in which impulses travel.

central tendon is involved; Plate IX when the costal portion of the diaphragm is involved.

Cough, if present, is usually a dry unsatisfactory hack. If an open tuberculosis is present the characteristic expectoration is present; if not, the sputum may consist of glary mucus.

On inspection, if the effusion is large, the patient is usually seen to lie on the affected side to allow the expanded lung to functionate to best advantage. Small effusions, however, cause little or no inconvenience, consequently may not influence the position of the patient.

Whether dyspnea is a factor or not depends very largely on the amount of the effusion. If large, such an amount of pulmonary tissue may be compressed as to greatly embarrass the patient. This is especially noticeable in patients suffering from marked bilateral tuberculous involvement when the apices are rendered inefficient because of the tuberculosis and the portions of the lung which functionate best are compressed by the effusion. Fortunately, this condition is rare. The largest effusions seem to occur in patients with small pulmonary lesions. Dyspnea is also caused by the pain and fear of taking a deep breath.

It is surprising to see what an amount of lung compression can take place with little inconvenience to the patient. We sometimes see chests in which one pleura is full of fluid without the patient suffering from marked dyspnea.

Diagnosis.—Making a diagnosis in cases of effusion may be easy or difficult according to the amount and location of the fluid. We have been in the habit of thinking that the effusion is always at the base, but this is not true; rarely it may be sacculated, or interlobular, and found in unsuspected portions of the thoracic cavity.

Inspection.—If the effusion is large, free and one-sided, the ribs may be seen to bulge; and from this alone the cause may be suspected. Besides the bulging the lower intercostals are apt to be widened and the motion of the side lessened.

Palpation.—The fluid may be palpated if the quantity is at all large. Progressively palpating the chest wall from above downward will show an increased resistance to the finger when the level of the fluid is reached.

Vocal fremitus is lessened or absent over the effusion and may be increased over the crowded lung above.

Percussion.—It is evident that percussion findings will vary with different conditions and different amounts of fluid. It is not always easy to determine the presence of fluid although present, especially when the amount is small. The impairment of the note may be slight and easily overlooked, so may the resistance to the finger. When the effusion is large, however, there should not be great difficulty in making the diagnosis by percussion.

The pulmonary tissue above the effusion, if at all compressed, shows a tympanitic note because of the relaxation of the pulmonary tissue.

Grocco's sign, the paravertebral triangle of dullness, which is found on the side opposite the effusion is commonly present and easily demonstrated in large effusions, but demonstrated with difficulty when the effusion is small.

Auscultation.—Auscultation commonly reveals a diminished respiratory murmur and decreased vocal resonance over the effusion. Fine râles are often heard in the pulmonary tissue above the level of the fluid.

Treatment.—The only question that needs to be considered here is whether or not the fluid shall be removed. This depends much upon the circumstances. My rule is not to interfere unnecessarily. The absorptive power of the pleura is such that if the patient is put under favorable hygienic conditions the effusion will usually take care of itself. I do not doubt, however, that in caring for patients with extremely low vitality who live under bad hygienic conditions, interference ought to be resorted to oftener. It is not improbable that absorption of the exudate is a form of autotherapy of some value.

It is possible that the pleural cavity may fill so full and so rapidly that the pressure of the fluid interferes with absorption. Under such circumstances the withdrawal of a small quantity of fluid will often relieve the tension over the pleural space and facilitate absorption. It is also possible for the mouths of the lymphatics to be closed by fibrinous flocculi and interfere with the absorption of the fluid. It often proves better treatment to remove such exudations because they seem to favor organization and the eventual obliteration of the pleural cavity, with more or less danger to the adjacent pulmonary tissue, and great embarrassment to the circulation.

I have long thought that tuberculin probably aids in the absorption of pleural exudates. If so, it probably acts by stimulating the vessels surrounding the tubercles on the surface of the pleura. Open air and hygienic living are of value in that they cause all body cells to functionate better, thus favoring absorption. Any tonic measure is of value for the same reason.

Pleural Adhesions.—Adhesions between the two leaves of the pleuræ are common. This leads to enormous thickening at times. The influence of this upon the organism is deleterious. It interferes with the inspiratory act and is usually accompanied by more or less fibrosis involving and extending into the adjacent pulmonary tissue, resulting in contraction of the same. As a result of these changes the circulation is more or less embarrassed. Aside from the changes in the pleura and lung, the external adjacent structures are also pathologically changed. This can be seen in the muscles and subcutaneous tissues as I shall describe later.

Changes in intercostal muscles and diaphragm in chronic pleuritis whether originating in the pleura or the underlying pulmonary tissue must be evident to all examiners who carefully palpate such chests. I called attention to this in one of my early papers on the changes in the muscles in intrathoracic inflammations.[4] What I was describing at that time was not wholly the condition of the muscles but the total resistance of all the tissues, including the lung under the point of pressure. A little later in my work I was able to differentiate the condition of the muscles as found on palpation from the condition of the underlying pulmonary tissues and show that infiltrations, cavity formation, emphysema, and other pathological conditions within the chest may be determined by palpation. I also determined later that the changes in the superficial muscles of the neck and chest, particularly the sternocleidomastoidei, scaleni, pectorales, trapezii, levator anguli scapulæ and rhomboidei are more valuable as physical signs of intrapulmonary inflammation and that the intercostals are of greater value in diseases of the pleura. Bönniger[5] noted the change in the muscles in pleurisy and exhibited cases before the Berlin Medical Society in May, 1910, showing it. He considered that this was the same condition that I had described. I had previously described and suggested that there was a motor reflex present in the superficial muscles when there was an inflammatory process affecting the tissues within, and had also noted the disturbance on the part of the intercostals which is doubtless due to direct extension of the inflammatory process, but Bönniger described the condition of the soft tissues over the inflamed organs as a one-sided lymph stasis affecting the skin, subcutaneous tissue and muscles, resulting from the changes in them, in such a way that the tissues became firmer and larger than normal. It is evident that he was describing more particularly the conditions which are found over thickened pleura. The soft tissues over thickened pleura often show marked changes but are not always easily determined. I have described them somewhat differently from Bönniger thus: *They are lifeless, doughy, lacking in elasticity and partly because of the changes in themselves, but probably more because of the changes in tissues underlying them, (thickened pleura, infiltrations or fibrosis in the lung) they offer increased resistance to the fingers on pressure.* This can be determined commonly both over the apices and bases, in fact, over any part of the lung.

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[4] Spasm of the Chest Muscles, Particularly the Intercostals, as a Physical Sign of Disease in the Lungs, American Journal of Medical Sciences, May, 1909.

The importance of this in diagnosis justly bears emphasis. Often the diagnosis of thickened pleura can be made as soon as the palpating fingers touch the soft tissues overlying. Not only are these changes in the soft tissues of diagnostic import themselves, but they influence the data obtained on percussion and auscultation in such a manner as to demand their recognition.

Percussion over tissues of this kind gives markedly different results from that over normal elastic structures. The tissues which have been influenced by the inflammatory process have a tendency to impair the note and offer greater resistance to the finger, aside from the condition of the underlying pulmonary tissues.

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[5] Über Halbseitige Lymphstauung bei Erkrankungen der Lunge bsw. Pleura, Berlin klinische Wochenschrift, June 20, 1910, Nr. 25.

Auscultation is undoubtedly influenced thereby. I have long been coming to the conclusion that many so-called pleural crepitations and pleural rubs and stretching sounds are produced in the inflamed and thickened pleural tissue itself and the muscles overlying it. It is extremely important to recognize this tissue element in the causation of râles because of the manner in which the prognosis is affected by our ideas as to whether the râles and other adventitious sounds are in the lung or in the tissues covering it.

The pathology of this condition has been well discussed by Dr. W. M. L. Coplin,[6] and I wish to quote extensively from his paper. Speaking of the lack of study of this condition he says:

> "So far as the writer is aware, no important study has been undertaken of the relation, if any, existing between the intercostal muscles and inflammations of the lung and pleura, or of either alone. An examination of the most important textbooks on medicine and pathology discloses no reference to the characteristic anatomical changes in the intercostal muscle or nerves in any of the conditions under consideration."

Coplin recognizes that there must be important changes on percussion and auscultation and states:

> "With full recognition of his entire unfittedness, it is not the writer's purpose to discuss the influence of the alteration in the intercostal tissues on physical signs, but any of the mentioned changes in the intercostal muscles would presumably influence the percussion note and probably modify the auscultatory sound.
>
> "With regard to the pseudopleural friction sound, called by the French *bruit de cuir neuf,* Rosenbach[7] accepts the conditions as a muscle phenomenon, and it is not improbable that other pseudopleural friction sounds are, at least, in part, of muscle origin. As will be shown later, pleurisy may be complicated with a myositis, and it would be of great interest to know if any friction sound results from movement in muscles the seat of inflammation. This could be determined, probably with great accuracy, by auscultation of muscles so situated as to exclude the probability of friction sounds arising from any other cause. It is well known that edema of collagenous membranes, such as tendon sheaths, may give rise to friction sounds, and it is not impossible that the septal fibers or septal membrane between the external and internal intercostals, and possibly the movement of fiber sheaths or bundles, one upon another, might give rise to such friction."

In studying the changes in the muscles and subcutaneous tissue in pulmonary and pleural inflammation one is confronted by the generally accepted idea that there is a universal degeneration of tissues in pulmonary tuberculosis, hence any change found must be *a priori*, a part of the general degenerative process. That aside from the general degenerative processes, there are local and regional causes operative I have shown both clinically and pathologically in my own study of these structures. The changes which Coplin describes are local and confined to the part involved; and, while changes may be found to be generalized, affecting the opposite side as a part of the general degenerative process in far advanced cachectic cases, the same pathological changes will not be so found in those who are free from the general malnutrition and degeneration.

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[6] Changes in the Intercostal Muscles and the Diaphragm in Infective Processes Involving the Lungs and Pleura, American Journal of Medical Sciences, May, 1904.

[7] Diseases of the Bronchi, Lungs, and Pleura, Nothnagel's Encyclopedia, 1903, page 845.

Coplin studied the intercostal muscles of seven cases of pneumococcal and tuberculous pleurisies, and grouped the pathological findings as follows:

> ''1. Muscle fibers showing marked granular change, inadequate tingibility, and unsatisfactory stain reaction, such as commonly observed in granular tissues, can be recognized in all cases. It is not clear that this granular degeneration or cloudy swelling can be attributed to inflammation in the adjacent serosa, as it closely resembles, indeed, is probably identical with, the cloudy swelling observed in muscles as a result of infectious processes where apparently the toxin is acting through the blood. It would, therefore, seem wise to regard this change as a part of an alteration affecting the general musculature, the intercostals, in common with other muscles, manifesting their share in the change induced by the systemic action of toxic bodies.
>
> ''2. With this alteration probably begin the changes that are incident to the involvement of and extension from the adjacent serosa. Muscle fibers are dissociated, the separation in some instances being quite distinct. The presence of a granular acidophilic deposit around the muscles and interfascicular connective tissue indicates that we are dealing with an edema; but few leucocytes can be seen in this stage. The muscle cells stain poorly; the connective tissue does not respond with its wonted activity to the usual connective tissue dyes. The component cells are swollen and granular, and occasionally a faint network of fibrin can be demonstrated at selected points. There is not, however, in this stage, any conspicuous addition of a fibrin-containing substance. With this condition, bands, groups and bundles of muscle fibers may be seen showing a change that, so far as I can observe, cannot be differentiated from the hyaline, vitreous, or diaphanous degeneration described by Zenker, known to occur in muscles of the abdominal wall in typhoid, and now recognized to be a much more widely distributed lesion often found in other conditions. In these hyaline areas muscle fibers often appear to coalesce, so that the hyaline change seems to include the interfascicular tissue as well as the muscle fiber. Whether this change be a secondary degeneration or necrosis, probably our present methods are inadequate to determine. That it is not identical with coagulation necrosis containing fibrin can easily be established by the absence of fibrin in some areas where the process now under consideration is conspicuous; we are

familiar with processes clearly necrotic and closely resembling, if not identical with, the change now under consideration, that could not, with propriety, be grouped with the necroses. As this, however, is neither the time nor the place to enter into the academic discussion as to what constitutes necrosis and what degeneration, it does not seem necessary to consider further the change present, the appearance of which is fairly well produced in Fig. 1.[8]

''3. It seems reasonable to assume that the stage now to be described is preceded, at least in some instances, by the alterations mentioned above. The dissociation of the fibers, the granular material, the areas of hyaline change, can still be recognized, or at least appearance of their having been present may be more or less fully identified. In this stage there is a leucocytic infiltration of the muscles similar to that shown in the photographs illustrating Rhorer's article. The leucocytes present in the specimen studied are mostly of the mononuclear type, many of them corresponding to the large lymphocyte or hyaline cell; the polymorphonuclears have not been exceedingly numerous; eosinophiles have not been identified in the altered areas. The dissociation, fragmentation, granularity, and necrosis of the muscle fibers are in this stage very much more evident. It is a diffuse process; some of the fibers appear to suffer to a marked degree, almost amounting to a necrosis, while others but slightly altered may be seen immediately adjacent, in a way resembling very closely the myocardial degenerations that have been described in various infectious diseases. Fibrin is abundantly present; bacteria may be conspicuous, while in the preceding form they were at most but scanty and usually absent. There is in this stage no difficulty in the identification of organisms that in the pneumonias and epipneumonic pleurisies may, with reasonable certainty, be considered pneumococci. Sometimes, the bacteria are grouped in the spaces between the muscle fibers in such a manner as to indicate dissemination along a lymph vessel, possibly only a larger lymph space.

''It has not been possible to secure specimens showing what might be looked upon as the next stage, and as to the ultimate outcome, should the patient recover, it is not possible at the present time to offer any unassailable opinion. Evidence of abscess formation is usually absent; the process seems more diffuse, but one can easily appreciate that the small necrotic areas infiltrated by polymorphonuclear leucocytes are really microscopic abscesses, such as can readily be demonstrated in the diaphragm. Our knowledge of the pathology of muscle inflammations leads us to infer that with the subsidence of active infection the necrotic muscle fibers would be removed by phagocytic cells (myoclasts); the interfascicular exudate would undergo absorption, and, with the formation of a certain amount of fibrous tissue, there would eventually result a moderate degree of muscle sclerosis. It therefore seems reasonable to assume that where the disease lasts a sufficient length of time,—where, in other words, the infection is permitted to continue—the changes between the stages just described and the conditions found in the specimen examined and reported below would fall under the head of the subacute or chronic sclerosing myositis, which, toward the end, would give rise to the picture presented in the following case.''

The explanation of the causes which operate to produce these changes as suggested by Coplin are important and deserve attention. I quote further from his paper:

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[8] The illustration mentioned has been omitted from this volume.

''It seems to the writer that the cause of these changes in the intercostal muscles is clear. Feiner has shown that after injecting fluids containing suspended granules into the pleura the extraneous matter may be demonstrated in the costal pleural lymphatics, and that but little resorption takes place through the pulmonary pleura. When we consider the fact that in inflammations of the lungs and pleura the interlobular and intralobular lymphatic systems can be seen engorged with products of absorption from the lung principally, we can understand how the parietal or costal lymphatic system must necessarily care for the major part of the drainage from the pleural cavity. This, being the case, toxic materials passing off by this route, are brought in close proximity to the intercostal muscles and diaphragm; it seems reasonable to assume that direct lymphatic paths may become occluded, being in close proximity to the centers of irritation, and, therefore, collateral currents must form through the intercostal muscles, thereby exposing them to the dangers induced by more or less persistent bathing in toxic lymph. If the infection be active or the resistance low, or both, the pathogenic organisms may be carried into the muscle, giving rise to suppurative processes, such as have been described by Rhorer in the diaphragm, and figured in one of the preceding cases as occurring in the intercostal muscles. If the bacteria be scanty or of indifferent activity or the patient's resistance high, they remain in the lung or pleura, and the muscles escaping direct infection suffer from the toxic action only.

''Where the irritation extends over a considerable length of time and granulation tissue with its protective influence against infection clothes the costal pleura, or where newly formed collagenous tissue is intercalated between the muscle and the altered serosa, then products reaching the muscle would probably be less active or materially modified toxins without evident bacteria. Here, then, results the chronic sclerosing change comparable to that seen in the muscles adjacent to tuburculous areas elsewhere in the body, as, for example, around tuberculosis of the hip, vertebræ, etc. In the more acute stages of the process the degenerative and necrotic change seen in the muscles may be attributed to the action of the toxins passing through the lymphatics of the muscles or diffusing into the muscle tissue. In the later acute cases bacteria themselves enter. In the cases of longer duration there might occur a chronic suppurative interstitial and parenchymatous myositis, but probably the patient would not survive an infection of this type, except purely as a local manifestation. The chronic alteration of importance is the sclerosing process by which the muscle is in part or almost wholly replaced by newly formed fibrous tissue in which fatty infiltration or lipomatous substitution almost constantly occurs.

''The influence of the changes already described on the thoracic wall so fully suggest themselves that a detailed consideration need hardly be given. The clinician will at once think of the modifications in physical signs—muffling and alteration in the ausculatory sounds depending upon increased density of the thoracic wall—brought about by any of the changes described, including serous infiltration, cellular accumulation, as well as fibrous and lipomatous change in the intercostal muscles; the influence of the change upon the function of these muscles will also be apparent. Even slight myositis is associated with rigidity, a more or less successful attempt at fixation, and this fully accords with the recognized clinical data.

''A large amount of space might profitably be devoted to consideration of the influence of the change upon respiration, but, as this is evident, I need not touch upon this point. Hamberger's observations on the functions of the intercostal muscles in respiration has received general acceptance, and has been corroborated by the studies of Newell Martin and Hartwell, Masoin, and R. du Bois-Reymond.[9] The fact that the internal muscles are actively operative in respiration only when the function is labored, renders more important the alterations now under consideration, because with alterations in the diaphragm, the principal muscle of respiration, and with the influence of intoxication upon the respiratory centers, and satisfactory evidence of narrowing of the intercostal spaces, as suggested by Przewalski, it becomes at once clear that structural alterations in these muscles must materially influence the alterations in chest volume upon which the air intake so largely depends. The fact that the external intercostal muscles are but slightly involved and often escape, does not modify this observation, because physiologists are fully familiar with the fact that opposing muscles are reciprocally influenced. Mention should be made of the influence of sclerosing myositis in the production of costal fixation in the chronic cases; whatever views may be entertained with regard to the inexpansibility of lungs long atelectatic, the condition of the ribs as regards motility cannot be ignored. The fixation of the affected side in acute cases may be, as is usually held, reflex, but it may also depend upon the spastic fixation of muscles (intercostal and diaphragmatic), the seat of pronounced architectural change.

''Structural alterations in the intercostal muscles possibly clear up to some extent the observations that intercostal rheumatism, intercostal neuralgia, etc., are complicating or associated phenomena of pneumonia and pleurisy. In this connection there are several factors in this field that the writer appreciates are not worked out. Probably the most conspicuous is alteration of the nerves. Some of the sections show nerves that appear edematous. In none of them has any cellular infiltration been observed. The tissues have not been prepared suitably for the demonstration of myelin degeneration, and this question must be taken up with some detail later. I might at this point, however, say that the sections show, what histologists so far as I know do not mention; namely, that nerve filaments, or even relatively large trunks can be seen coursing between the internal intercostal muscles and the adjacent pleura. They are so situated as to expose them to all the toxic substances permeating the adjacent muscle. In one block of tissue from an acute case two relatively large nerve bundles can be seen immediately below the serosa embedded in a small cushion of fat; the epineurium touches the serosa, and a vessel lying in immediate proximity contains, on transverse section, seventeen erythrocytes, two polymorphonuclear leucocytes, and one hyaline cell—presumably a local leucocytosis. The nerve bundle is retracted from its sheath, on the inner aspect of which can be recognized transverse sections of two capillaries containing red cells, but no leucocytes; there is no leucocytic infiltration of the sheath or nerve. Another specimen contains a longitudinal section of a nerve that at one point shows a suggestion of cellular infiltration and contains a widely dilated capillary. Such axis-cylinder stains as have been applicable to Zenker material demonstrate no noteworthy change in the myelin sheaths, and the axis-cylinder of the nerves, but, as usual, in such material, myelin stains have proved unsatisfactory.

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[9] The details of muscular action in respiration are fully considered by Starling in Schäfer's Text-Book of Physiology, vol. ii, pp. 274-280; he also cites the authorities to whom I refer.

''The foregoing offers no sufficient anatomical basis for the conclusion that the nerves suffer; nevertheless I am satisfied that in such instances as the one narrated they cannot long escape. Their perilous situation exposes them to the noxious influences of infection, toxic bodies, and other coincidents of inflammation, to the action of which nerve elements are conspicuously susceptible. It would be interesting to know if the clinicians have observed any paralytic phenomena that indicates a toxic degeneration or neuritis involving the phrenic nerve or motor branches of the intercostal muscles. Alteration in the sensory fibers is strongly indicated by certain of the clinical factors; will the clinicians kindly advise us what, if any, symptoms or physical signs point to motor involvement? I feel reasonably certain that there is no sufficient reason why the motor nerves should escape.

''An extremely important point to be determined is whether there are any lymphatic ways corresponding to intercostal spaces in which this change is most marked. While I have no information that would justify a positive conclusion upon this point, the fact that well-marked changes may be seen in one area of an intercostal muscle, and the block of tissue from the adjacent neighborhood fails to show the alteration, leads to the belief that the lymphatic course or tract should merit special consideration, and it appears that in a very general way only have the anatomists and histologists solved this problem. Possibly we have, in what might be called pathological injection of the lymphatic spaces and vessels, an important adjuvant in the study of the lymph courses. I have had no opportunity to study the changes in the lymph trunks draining the costal pleura; such a study based upon experimentally produced inflammations of the lung and pleura, is needed.

''An important question suggested by Dr. Riesman is what would the intercostal muscles of the sound side show? In one of the cases of pneumococcal pleurisy the muscles of the other side escaped, or at least showed no structural change. I am not inclined to believe that the opposite side is involved, unless thrombosis of the costal lymphatics of one side might lead to an anastomotic current passing to the other; such spanning of the mediastinum would seem improbable.

''Another point upon which these studies are inadequate is the frequency with which the intercostal involvement occurs. Five of the seven cases studied are Philadelphia Hospital patients, and those familiar with the Blockley morgue know that we may draw incorrect conclusions as to the frequency of concurrent conditions, because we are dealing with a class in whom coincidence of pathological processes is a conspicuous feature.

''Kuettner[10] has made an exhaustive study of the perforating lymphatics of the diaphragm. He shows that the drainage territories of the diaphragm are such that abundant opportunity is afforded for transdiaphragmatic infection, and has so worked out the lymph paths as to show that while each half of the organ possesses its own lymphatic field communicating with other parts by way of lymph nodes only, all parts of the diaphragm possess anastomotic communication with the pleura and peritoneum. The anterior and posterior lymph vessels communicate and drain in common into certain glands; some of these vessels vertically traverse the diaphragm twice in coursing over it. Taken with the studies of Rhorer and my own observations, it seems that Kuettner's work forms the necessary link in completing our already fairly full comprehension of the possibilities of transdiaphragmatic infections. That a juxtaposed abdominal viscus may infect the pleura or pericardium (e. g., hepatic, splenic, and perirenal abscesses and gastric ulcer) has long been common property, but that lesions of a finer texture may be recognized, and that the four great serous cavities are really intercommunicating lymph spaces is within recent times leading to deductions some of which may be important. Is it possible that the pneumococcal inflammations of the peritoneum (even when primary) may be transdiaphragmatic infections, the lung and pleura escaping in some cases? The frequency with which the ribs suffer typhoidal osteomyelitis is suggestive, and if, as Franckel holds, the typhoidal spondylitis is really a bacillary infection of the cancellous tissues of the bodies of the vertebræ, the demonstration of abdominal and thoracic lymph system as so closely allied threatens, as a result of a minor disclosure, to lead one into a labyrinth of unjustified speculation.''

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[10] Thirty-third Congress German Surgical Society, June, 1903: Centralblatt für Chirurgie, 1903, Nr. 36; Beiträge zur klinische Chirurgie, Tübingen, Bd. xi, Nr. 1.

The importance of this discussion as bearing upon the clinical picture of thickened pleura cannot be overestimated. The aching which occurs in these cases and which is so often described as rheumatic, has a suggested explanation in the pathological changes which they undergo.

The question of the motility of the diaphragm is of vast importance, not only as a sign of diagnostic import in that it points to the presence of pathological changes on the corresponding side of the chest; but also because of its influence on the inspiratory act and the further disturbance in the circulation of the blood and even the heart and vessels, as described more fully in Volume I, Chapter XI.

The importance of recognizing the pathologically altered intercostal muscles and subcutaneous tissue as signs of inflammation of the underlying pleura is emphasized throughout these pages. I have considered these changes as having diagnostic merit, and have employed them in everyday practice during the past eight years.

Diaphragmatic Pleurisy.—When the pleura covering the diaphragm is involved our symptomatology is different from that usual to the costal pleura. The pain instead of being in the side corresponding more or less closely to the underlying inflammation, may be referred to other parts, the peculiar localization depending upon the innervation of the pleura. Thus, diaphragmatic pleurisy involving the costal portion may be accompanied by a spasm of the upper abdominal muscles and a pain located in the same area. This motor and sensory reflex is largely from the tenth, eleventh and twelfth thoracic segments which supply the peripheral portion of the diaphragm and the upper abdominal wall with motor and sensory filaments. This pain and spasm is at times mistaken for evidence of disease in the upper abdomen, as previously mentioned. The other localization for diaphragmatic pleural pain is in the shoulder. This is noted when the central tendon is the seat of inflammation. This is the result of a developmental vestige and depends upon the fact that in lower life the diaphragm is high in the neck on a level with the cervical segments and receives part of its nerve supply from them. The pain is in the third and fourth cervical zones and its path is through the phrenics which take their origin from the third and fourth or fourth and fifth cervical segments and to the tissues over the shoulder which receive their sensory reflexes through the nerves from the third and fourth cervical segments as previously mentioned.

Capps[11] has made an important contribution to the study of diaphragmatic pleurisy in a careful analysis of sixty-one cases. The character and location of the pain as determined by him is shown as follows:

> ''During a six-year period sixty-one cases of diaphragmatic pleurisy have been seen and examined by the writer. Such a collection would have been impossible had it not been for the interest and courtesy of the internes and staff of the Cook County Hospital.
>
> ''Twenty-nine of the cases had a lower lobe pneumonia with associated pleurisy, the remaining thirty-two had pleurisy alone.
>
> ''Thirty-nine were situated on the right side, twenty-one on the left and one was bilateral. The diagnosis was in most instances made evident by physical findings in the thorax, in four instances confirmed by autopsy, and in six instances abdominal disease was excluded by exploratory laparotomy.
>
> ''*Pain* referred to parts distant from the seat of inflammation was the outstanding symptom in these cases. *Referred abdominal pain* was present in fifty-four cases, in all cases involving the upper quadrant (7 to 10 dorsal segments), and in twenty-five cases the lower quadrant as well (7 to 12 dorsal segments). Bilateral pain in the belly was noted four times.
>
> ''The pain was usually spontaneous and with it was tenderness to pressure. *Hyperesthesia* and *hyperalgesia* of the skin were almost constant and showed a decided tendency to follow band-like areas, corresponding to different spinal

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[11] Clinical Study of Pain Arising from Diaphragmatic Pleurisy and Subphrenic Inflammation, American Journal of Medical Sciences, March, 1916, vol. cli, No. 3.

segments. Over this sensitive area the *musculocutaneous* reflexes were exaggerated and often the wall remained in a state of rigidity.

"The *maximum points of pain* and tenderness to pressure were especially studied (Fig. 107).

"This point was located:

(a) In the gall-bladder region, 10 times.
(b) Lateral to and slightly above the navel, 15 times.
(c) Near McBurney's point, 2 times.
(d) Over the navel, 1 time.
(e) Midepigastrium, 1 time.
(f) Splenic region, 1 time.
(g) Lumbar region, 2 times.

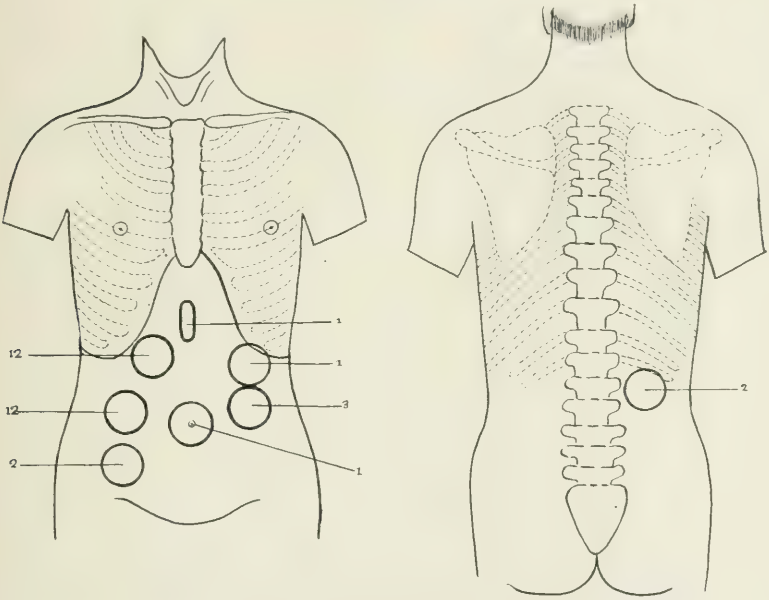

Fig. 107.—Illustrating the points of maximum abdominal pain and tenderness to pressure in diaphragmatic pleurisy. (Capps.)

"*Referred neck pain* occurred in thirty-three cases, or in a little more than one-half of the total. The pain was located by the great majority of patients along the trapezius ridge, occasionally over the shoulder cap and in the supraclavicular space. These areas are all supplied with sensory nerves by the third and fourth cervical spinal segments.

"The pain was usually spontaneous and of a sharp stabbing character, always well localized by the patient with the tip of his finger. Pressure over this point was often very painful. The skin and subcutaneous tissues in the immediate neighborhood showed the same hyperalgesia and hyperesthesia as were found over the abdomen, but the point of maximum pain and tenderness in the neck was sharply localized, and more constant.

"The exact locations of maximum pain points are illustrated in Fig. 108.

"*Factors Influencing Pain.* The appearance of referred pains in the abdomen or neck was generally early in the course of the disease. More often abdominal pain preceded the neck pain when both were present. The *duration* of the pain and tenderness varied in much the same way as in parietal pleurisy. Sometimes the pain disappeared after a few hours; as a rule it persisted for one to three days and occasionally for over a week.

"The pain was nearly always induced or aggravated by cough and deep inspiration, especially during the acute stage.

"Measures limiting the excursion of the diaphragm on the affected side, such as lying on the painful side or tight pressure of an abdominal band often gave relief. Some patients secured ease by lying doubled up on the affected side with the shoulder held down by a pillow.

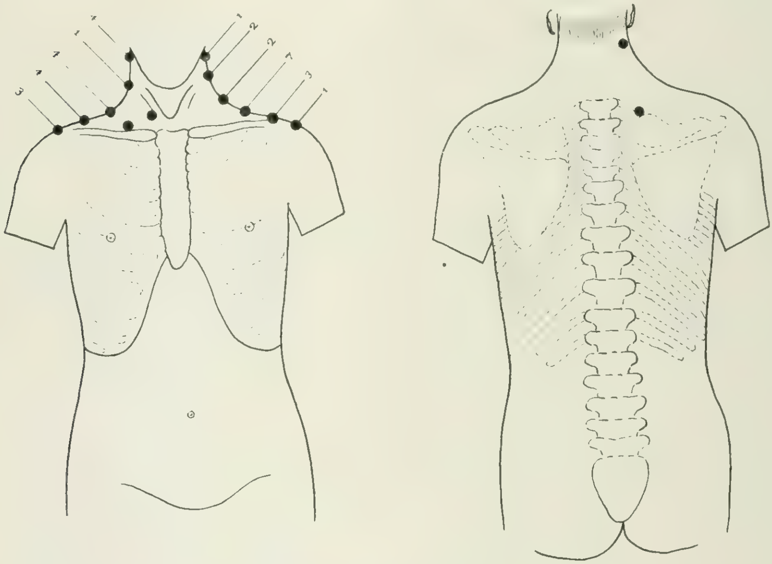

Fig. 108.—Illustrating the points of maximum referred pain in the neck in diaphragmatic pleurisy. (Capps.)

"*Special Features.*—The abdominal pain was associated with a maximum point of pain and tenderness far more frequently on the right than on the left side. Such a point was observed in twenty-five out of thirty-six cases on the right side or seventy per cent; while it was noted in only 7 of 18 cases on the left side, or forty per cent.

"In contrast to this disparity, the neck pain occurred with almost equal frequency on the two sides. *Tenderness of the phrenic nerve,* a symptom emphasized by many writers was found in but one case and that was doubtful. Vomiting was present in ten cases and was often responsible for a mistaken diagnosis of abdominal inflammation. *Hiccough,* another symptom supposed to be common in diaphragmatic pleurisy, was noted in only five cases, being unusually severe, however, in three."

In his study of the differentiation of pain in diaphragmatic pleurisy and inflammation of abdominal viscera, he says:

"Our knowledge of visceral pain has been so enriched by physiological investigators, more particularly by Hilton, Ross, Mackenzie, Head, Meltzer, Lenander and Hertz that we should interpret our clinical findings in the light of their results. Without discussing their work in detail, we may recall that Lenander and Mackenzie have maintained that the viscera are insensitive to pain, since during operations under cocaine the stomach, intestine, appendix, gall-bladder, and other organs may be cut, burned, and scratched without producing any painful sensation. All pain proceeding from abdominal inflammation they believe arises from irritation of or traction on the parietal peritoneum, which is supplied by spinal nerve fibers that are specially designed to carry pain stimuli to the cord and brain. The sympathetic nerve fibers supplying the viscera, they say, do not have the power to carry painful stimuli.

"These conclusions must be modified by the observations of Kast and Meltzer, who found that the sensibility of the viscera during such operation is appreciably lessened both by the general toxic effect of cocaine and by exposure to the air.

"It has been pointed out by numerous investigators that the viscera may be insensitive to the ordinary painful stimuli such as cutting and burning, and yet be sensitive to the 'adequate stimulus.' The adequate stimulus for all hollow viscera seems to be *tension.* As a result of tension the pain of colic may be explained.

"The theory that generally prevails today is that proposed by Ross and supported in essentials by Head; viz., that there are two distinct types of pain in visceral inflammation.

"1. *The splanchnic or visceral pain,* which is conveyed directly to the cord and brain by the splanchnic nerves. This pain is, as a rule, dull and deep. A good illustration of this pain is seen in pressure on the testicle or over an inflamed ovary, appendix, or gall-bladder. As a rule, it is localized near the site of its origin.

"2. *Somatic or referred pain* is usually located at some distance from the seat of inflammation. It is produced when afferent stimuli from the viscera travel along the splanchnic nerves to the posterior roots of the cord, where they so irritate the corresponding spinal somatic nerves that they give rise to pain in the area of skin and muscles supplied by these nerves.

"This pain has a band-like distribution over the trunk, and an irregular distribution over the neck, head, and extremities. The pain is in the skin, subcutaneous tissues and muscles and therefore superficial. The sensitized area is hyperesthetic, hyperalgesic and often characterized by painful tender points. The muscular cutaneous reflexes are exaggerated. When the parietal peritoneum is involved then there is a direct irritation of the spinal somatic nerve which is similar in kind to referred pain along the same nerve. It is reasonable to expect that both types of visceral and referred pain may be present in visceral inflammation. But clinical experience seems to show that the visceral pain is more constant in abdominal affections than the referred, also that visceral pain may occur alone, e. g., in intestinal colic and some cases of catarrhal appendicitis. Referred pain from the diaphragmatic pleurisy renders painful the spinal nerves supplying the abdominal wall, but the deep visceral pain is not present. Steady deep pressure over the appendix or gall-bladder is well tolerated, whereas in inflammation of these organs deep pressure gives rise to severe deep-seated pain.

''The main point of differentiation between diaphragmatic pleurisy and inflammation of the abdominal viscera are as follows:

''1. The skin and muscles of the abdomen are more sensitive to pain and touch in referred pleural pain than in visceral disease. This is best elicited by pinching of the wall and scratching of the skin.

''2. The cutaneous reflexes are more lively in referred pain than in visceral disease as a rule.

''3. Deep pressure with flat surface of the fingers is well borne in referred diaphragmatic pleural pain, while it elicits a dull, deep pain when applied over an inflamed organ; e. g., an appendix or gall-bladder.

''4. Evidences of respiratory infection are usually present in diaphragmatic pleurisy, such as cough, expectoration, herpes of lips, sore throat, high leucocytosis, rapid respiration, etc.

''5. Appearance of a sharp, definitely localized pain in the neck on the same side as the abdominal pain often reveals the true condition, since it points to an irritation of the phrenic nerve.

''6. The referred pains in the neck and abdomen are usually induced or aggravated by cough and deep inspiration.

''7. Nausea and vomiting are more constant in visceral abdominal inflammation, but may occur and be very pronounced also in diaphragmatic pleurisy.

''8. Hiccough is not a common symptom in diaphragmatic pleurisy, contrary to the current belief. It was present only five times in our series of sixty-one cases. It is more often seen in visceral diseases of the abdomen than in diaphragmatic pleurisy.''

Treatment of Pleural Pain.—Pleural pain may be relieved by fixing the chest wall so as to limit motion. Several straps of adhesive plaster, two inch being preferable, should be applied across the ribs, beginning anteriorly across the sternum and passing downward and backward beyond the spine. Cough should be relieved by heroine or codeine or when pain is worse, morphine, $1/8$ grain, as needed, or Dover's powders, 2 grains, as needed may be used. Dry heat is always valuable.

CHAPTER XXVI.

SPONTANEOUS PNEUMOTHORAX.

Pneumothorax may be caused occasionally by different processes such as trauma, subdiaphragmatic inflammation and rupture of the esophagus; but ninety per cent of all cases are due to tuberculosis.

This complication of tuberculosis, as a rule, comes when the disease is well advanced, and, in many of the cases which I have observed, it has been preceded by symptoms of activity in the tuberculous process and quite often there has been a localized pleuritis, accompanied by pain, for a few days prior to the rupture into the pleura.

The pneumothorax may be complete and result in the compression of the entire lung; or, as is more common, it may be partial; complete collapse being prevented by pleural adhesions, or closure of the aperture before the pleura is filled.

The effect of pneumothorax upon the patient differs greatly. In some cases where it comes on suddenly and is complete, the distress is such as to cause great anxiety, and, in rare instances, it is followed by immediate death. As a rule, however, if followed by death, it does not occur until several days, and, more cften, several weeks later. In my experience I have not found it attended by so high a death rate as is usually mentioned; in fact, have seen only a few deaths produced by the pneumothorax directly. My experience differs also in several other particulars from the usual description of this condition as will be mentioned as the discussion proceeds. This difference may be due in part to the character of my material, which is made up, for the most part, of chronic widespread fibro-ulcerative cases.

There is no doubt in my mind that this condition is far more common than is generally believed, but that it goes undiagnosed. We admit to the sanatorium one or two patients a year suffering from pneumothorax in whom it has not been suspected by the previous attendant. This is not to be wondered at, however, especially in case of small and incomplete pneumothorax, if the physician is called to see the patient for the first time during the attack, with no knowledge of his previous condition. Where the patient has been under observation and the physician knows the condition of the chest, the difficulty is not so great. The x-ray is of undoubted value in diagnosis of this condition, particularly in small incomplete cases. Of the advanced material in the Pottenger Sanatorium pneumothorax is a complication in about ten per cent.

Many authors writing on this subject express the view that pneumothorax depends on exertion or strain. Nearly all of the cases which have come under my observation have come on while the patient was resting in bed, often while sleeping. Of course, such patients are often troubled with an increased cough a few days preceding the rupture. This is particularly true when acute softening is occurring if the area of inflammation is at all large; but many instances of pneumothorax come from very small foci, and come on without any apparent change being noticed in the patient's previous condition. The pathological changes which the tubercles undergo in causing pneumothorax are the same as those in tubercles in any other situation. They form, become necrotic, caseate, and rupture. The only difference is that in this instance they rupture into the pleural cavity instead of into other tissues or a bronchus. While exertion might favor such rupture; yet it is bound to occur in the natural course of events. Unless sufficient inflammatory changes have occurred to cause the pleuræ to become adherent, a caseating tubercle on the surface of the lung will often break into the pleural cavity as being the direction of least resistance.

Symptoms.—Pneumothorax comes on suddenly in about one-third of the cases which I have observed and slowly in about two-thirds.

We must not expect pneumothorax to always come on with sharp pain followed by great dyspnea, and show an absence of breath sounds on examination. The character of the onset depends greatly upon the extent of the tuberculous process in the lungs, the presence or absence of adhesions of the pleuræ, the extent and character of the opening and the general state of the patient.

Temperature.—The most constant symptom which I have observed is a sharp rise in temperature and pulse as shown in the charts appended. (Figs. 109 and 110). When the temperatures are charted carefully, I have rarely seen this type of sudden and sustained rise caused by any other process. This accompanies slight and severe cases alike in my experience, although I have noted an immediate drop in a few of the more severe cases followed later by a rise. The type of temperature mentioned by Fowler[1] I have not found to be the rule. He speaks as though the temperature falls in practically all cases. Why there should be this discrepancy in observation in this important symptom, I do not understand. Why spontaneous pneumothorax should be followed by an immediate rise of temperature and induced pneumothorax often be followed by a fall in temperature is also a question to be answered. Often spontaneous pneumothorax is followed after a week or ten days by a fall in temperature. This is not infrequently noted when the patient has been previously suffering from fever such as accompanies necrosis and caseation, and is due to the fact that the patient is relieved of an active necrotic process and its attendant absorption of toxic material.

Pain.—Pain precedes and accompanies many cases of pneumothorax, but it is not a constant symptom. Many cases come on without any pain at all. The pain may be sharp and stabbing in character or dull and accompanied by little discomfort. The pain may not be at the point of rupture, but widely separated from it and be caused by stretching and breaking up of adhesions between the visceral and parietal pleuræ. Sometimes, owing to the pressure, great discomfort is experienced when the collapse is extensive. At other times, and more commonly, it is only a feeling of fullness of which complaint is made.

Dyspnea.—This may be an important symptom or it may be wholly lacking. Many cases of partial or limited pneumothorax are found where there is no noticeable embarrassment to respiration. If the lesion occurs on the side of extensive pulmonary involvement (and I have found it so in the great majority of my cases) it may not put enough of the functionating lung tissue

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[1] Fowler and Godley: The Disease of the Lungs, Longmans, Green & Co., New York, 1898.

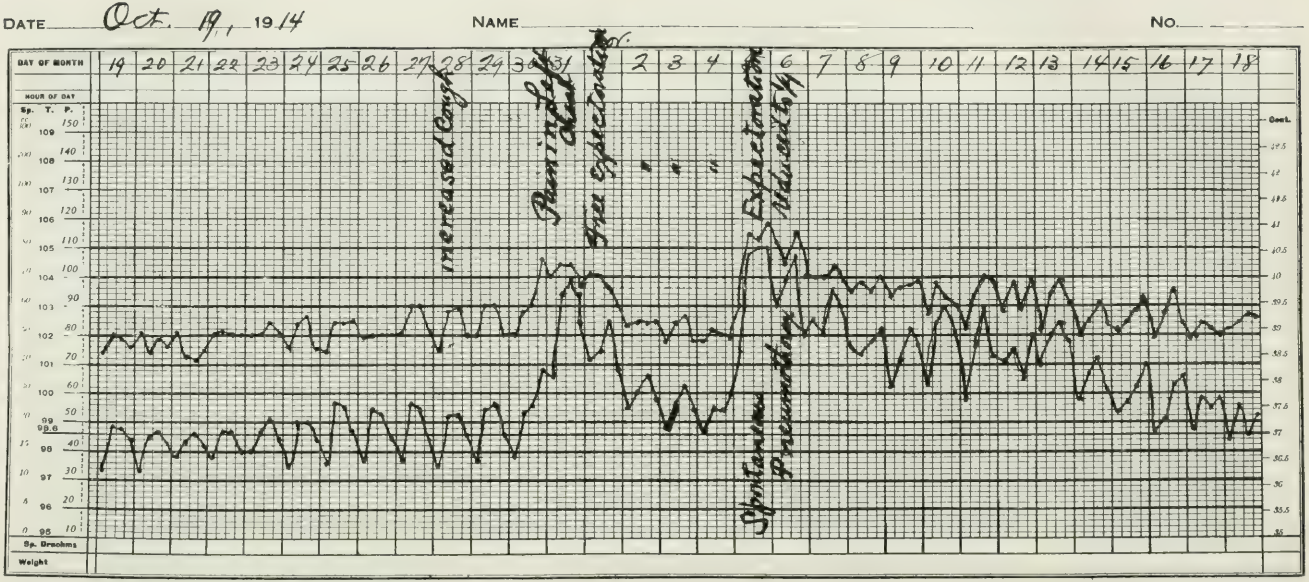

Fig. 109.—Showing spontaneous pneumothorax. Sharp rise in temperature and pulse. First rise in chart due to rupture of tuberculous abscess resulting in cavity. Second rise due to spontaneous pneumothorax. Upper curve, pulse; lower curve, temperature. Note the manner in which both pulse and temperature are sustained following the pneumothorax as compared with the more rapid fall following the rupture of the abscess.

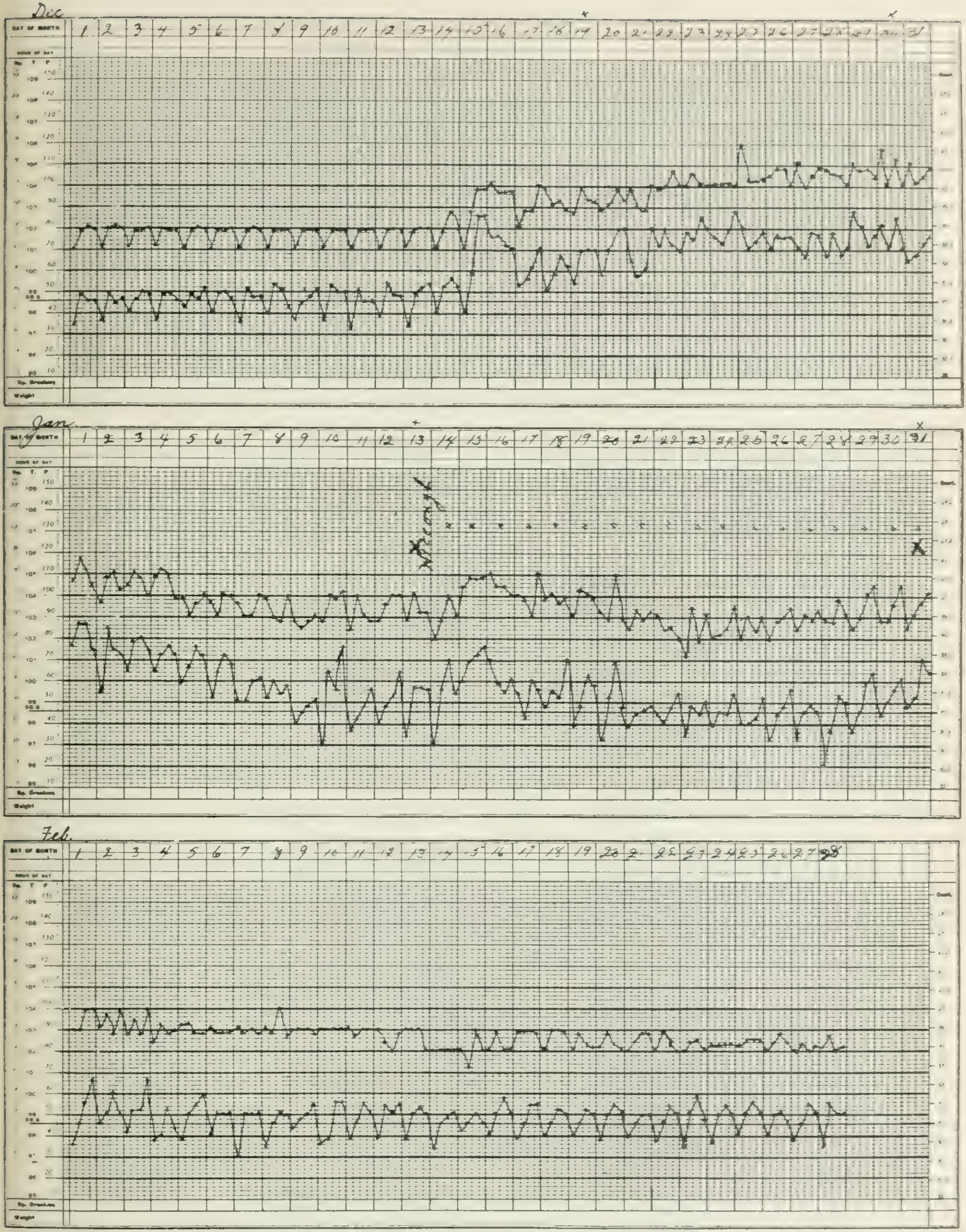

Fig. 110.—Showing spontaneous pneumothorax occurring in the course of clinical pulmonary tuberculosis, followed by an unusually serious condition and later by an arrestment of the disease. Pneumothorax occurred on the 15th of December. The sudden rise in pulse and temperature curve with sustained rise following is characteristic of spontaneous pneumothorax. Patient suffered from hiccoughs continuously from January 13th to 31st, during which time death was expected at any time. Upper curve, pulse; lower curve, temperature.

out of use to cause appreciable embarrassment. If, on the other hand, one side is severely diseased and pneumothorax occurs on the less involved side, suffocation may threaten or actually take place. In such instances the patient is found usually sitting up in bed fighting for breath. Fortunately, this is not common. Not only is the dyspnea caused by an insufficiency of pulmonary tissue for aerating the blood, but by reflex nerve irritation and the embarrassment of the circulatory system, which becomes a factor in all instances to the extent to which the heart is burdened. Sometimes this is slight. Sometimes it is a very important factor.

In this connection we must recall that the heart bears the brunt of advanced tuberculosis. Its work of forcing the blood through the lung becomes a serious one when large areas of vessels have been destroyed. It measures up to its extra work by strengthening the right heart through hypertrophy. This it is able to do in chronic tuberculosis because the disease progresses slowly and the strain is increased gradually. But, when the disease has become extensive and the heart has already used up its compensatory power to a large degree, it cannot have a call for extra work thrown upon it without showing the effect of the burden.

One of the particular features of the heart in advanced tuberculosis is its inability to measure up to sudden increased demands upon it because it has already been working on its reserve strength. A large burden is thrown upon it in pneumothorax. A demand is made without it having its full reserve to call upon, and without having time for adjustment to take place. The result is an immediate show of embarrassment if the extra burden is great. This manifests itself in a weak rapid pulse and a general cyanosis. A deficient inspiratory act is also present.

The pulse usually shows a sharp rise of from ten to twenty or thirty beats, according to the severity of the complication; and, in fatal cases, this increases as the heart dilates and death approaches. In favorable cases, the pulse rate is usually sustained for a few days and then gradually falls with the temperature.

Cough is usually increased. The displacement of the mediastinum, causing dragging on the laryngeal nerves; the stretching of pleural adhesions; and the extra work thrown on the other lung, causing increased motion of areas which are the seat of tubercles, often active, increases the tendency to cough.

Pneumothorax often causes a diminution in the amount of secretion coming from the lung. The extent of this diminution depends on the completeness of the collapse and the condition of that portion of the pulmonary tissue which is collapsed. If it is fairly complete and occurs on a side in which the underlying lung is the seat of acute cavity formation, and in which the walls have not become too thick and fibrous, it compresses the cavities and thus diminishes the secretion. On the other hand, the pneumothorax might be so circumscribed and so situated either on account of adhesions or because it affects portions of the lung which are free from active destruction, or because of thick cavity walls, that it would not be able to affect the secretion to any marked degree. Now and then it affects a lung which is the seat of only a slight involvement and consequently has little opportunity for affecting secretion.

In my cases of pneumothorax complicating advanced ulcerative tuberculosis diminution of sputum has been almost invariably present, and I have learned to place reliance upon it as a diagnostic sign. The reason for this is that the pneumothorax has nearly always occurred on the side having the greatest number of secreting cavities and has been able to produce a certain amount of collapse in them.

Loss of Consciousness.—When the pneumothorax is complete or extreme, coming on suddenly, all symptoms are exaggerated; and the patient often assumes an apathetic state, or lapses into complete unconsciousness, for a time.

Inspection, Palpation, and Percussion.—The information which one derives from examination depends upon the proper interpretation of preceding conditions. Low position of the diaphragm, bulging of one or the other side, and displacement of the mediastinum are common in advanced tuberculosis as a result of the changes which occur in the course of the disease, and are of no diagnostic value alone. When the mediastinum is found pushed to the side opposite to what it should be, however; or, the diaphragm is found pushed downward when it should be high; or the side is found bulging when it would be natural to have a retraction, then an accumulation of either air or fluid in the pleura should be suspected, and some of the other signs and symptoms should be looked for to complete the diagnosis. These signs will often be found because the pneumothorax occurs on the side of greatest destruction of tissue.

If the pneumothorax is extensive and the pericardium free, inspection will often detect the displaced heart impulse and show that it is in the wrong place as judged from the general contour of the chest and the atrophied subcutaneous tissue and muscles, even if percussion and auscultation have not been carried out.

Palpation reveals the displaced mediastinum as a whole and when taken into consideration with the resistance felt over other portions of the chest will usually reveal whether or not the displacement is due to the pulmonary condition alone or to a filling of the pleura. This is of value only when the mediastinum is displaced.

Vocal fremitus cannot be relied upon although it is apt to be lessened and may be absent over the pneumothorax.

Bulging of the side and widening of the intercostal spaces is usually present when large quantities of air above have entered the pleura, although pneumothorax may be present without any visible or palpable change.

A valuable sign to one who has learned to differentiate between different degrees of density of underlying tissues by palpation is the lessened resistance on palpation detected over the pleura containing air. This is even more marked than that conveyed by emphysema. Not only is there a feeling of less density but often one of increased tension, the same as found in marked emphysema.

Percussion shows so many variations that I have not found it alone very reliable. There are many things to consider; the shape and extent of the pneumothorax, its position, the air tension in the pleura, the presence or absence of adhesions, and the character of the pulmonary tissue. The note may be such as is found over a large cavity or over an emphysematous lung. It is usually hyperresonant; it may have a decidedly tympanitic quality; and in case the air tension is great it may be dull.

Error sometimes arises in the lower left chest because of the tympany from the stomach and colon. Palpation is of more value here in determining the absence of pulmonary tissue. Percussion also enables one to determine the shifting of the mediastinum.

Auscultation.—Auscultation may reveal no particular change in breath sounds that is distinctive. Diminished breath sounds such as would be expected when the lung is collapsed are often no more marked than is found over thickened pleura or the base of a lung that has been the seat of scattered tubercles. A respiratory murmur not markedly different from that normally heard over the areas involved is not uncommonly heard; and even may be heard over a chest wall when the underlying lung tissue is collapsed and withdrawn from contact. As a rule, however, some diminution of the auscultatory sounds is usually noted.

Metallic Tinkling.—This may be heard at times, but it is also heard over large cavities and so is not pathognomonic.

Succussion Sound.—This may be heard on shaking a patient when fluid is present, but this is rarely of diagnostic value.

Coin Sound.—The coin sound is a bell-like sound heard by the examiner listening over the chest wall when a coin is laid on the chest on the opposite side and this is struck by a second coin. It is commonly present when the pneumothorax is large. It may also be heard over large cavities.

X-ray.—The examination of the patient with the screen or plate is valuable. Diagnosis can readily be made and the progress of the case can be studied in this manner. Often atypical cases can be detected by the x-ray when they are overlooked on ordinary examination.

Diagnosis.—The points which I have found to have the greatest weight in diagnosis might differ somewhat from those relied upon by the physician who does family practice and is consequently often called to see the patient for the first time during the attack of pneumothorax.

In the sanatorium where the patient is under a regime of regulated rest and exercise, where the amount of cough, sputum, the pulse rate and temperature are recorded and where the results of careful physical examination are charted, any variation is at once noted.

When I see a sudden rise in temperature and an increase in the pulse rate coming on within a few hours as shown in Figs. 109 and 110, especially if it is accompanied by a decrease in the amount of expectoration, I am at once suspicious of pneumothorax, whether there is any pain or not, or whether dyspnea is marked or not. Usually coincident with these symptoms, but sometimes later, there is a feeling of fullness in the chest, even if a distinct pain is not experienced. Palpation and percussion, in case of a moderately well filled pleural cavity, will usually show a displacement of the mediastinum and a pushing down of the diaphragm on the affected side from the position shown on the record. Hyperresonance and tympany, as well as weakened breath sounds, may also be important in aiding diagnosis.

If called to see a person for the first time during an attack of pneumothorax, we would expect the collapse to be rather extensive and the dyspnea and pain to be severe; otherwise a physician would not be called. Under such circumstances shifting of the mediastinum should nearly always be found; hyperresonance or tympany, or, if tension is great, dull tympany should be well marked; and a diminution in breath sounds and probably also in secretion, together with increased cough, should be expected. The temperature will usually be markedly elevated, but may be greatly depressed. In extensive pneumothorax the mind is usually disturbed and unconsciousness may be present.

Varieties of Pneumothorax.—A practical classification of pneumothorax is: those cases where the rupture closes and those where it does not. Often the opening closes at once on the collapse of the lung and remains so. Such cases are not serious, as a rule, because the collapse is neither extensive nor is it so sudden as to embarrass the heart.

Those which fail to close, the so-called valvular type, are serious. The pleural cavity may fill suddenly, or it may require several hours or several days to do so. The inspiratory act opens the rupture and forces air into the pleural cavity, while the expiratory act closes the opening and prevents air from escaping. Consequently, there is an ever increasing pressure which crowds the good lung, and increases the heart embarrassment. The second danger is that of infecting the pleura and thus setting up a pyothorax. As long as the opening is patulent, there is danger of this occurring. That pyothorax does not regularly follow the rupture of caseating tubercles into the pleural cavity is a point against the formerly held theory that cavity formation is a pyogenic process due to mixed infection.

In cases where the lungs have not been the seat of active disease or where the disease has been very limited in extent, or, if severely diseased, the pneumothorax occurs on the better side, it is, as a rule, very serious because of the sudden and extensive collapse which occurs. Under such circumstances, there is no time permitted for compensation to take place. Not only is one lung rendered wholly useless but a certain portion of the other one as well; for, as the mediastinum is pushed over, the good lung is subjected to a certain degree of compression which limits its functionating power. This sudden limitation of the respiratory area, together with the coincident circulatory embarrassment, brings about conditions which render the proper aeration and distribution of the blood impossible. Consequently, death may occur before compensation can be established.

Where the lungs have been the seat of marked disease, pneumothorax may result in either benefit or harm to the patient. If the disease is largely one-sided and the pneumothorax occurs on that side, improvement may follow, providing infection of the pleura does not occur. If it occurs on the other side, harm is almost sure to come. The symptoms are usually slight under the first condition and severe under the latter.

If the opening fails to close it proves to be much more dangerous when the pneumothorax occurs on the better side; for the compression is more extensive and the difficulties of making proper compensatory changes are greater. On the other hand, there is greater danger of infecting the pleura when the more extensively and actively diseased side is involved.

Pneumothorax is quite often the culmination of a siege of toxemia with its attendant fever. A tuberculous mass near the pleura has become necrotic and caseates. Toxins have been given out into the tissues and the process has been attended by a rise in temperature. The rupture comes, the pleura is filled with air, the caseating area is compressed, absorption is checked and the temperature drops. All is well unless the pleura becomes infected or the disease becomes active in the parts which are subjected to extra work, or the heart is affected by the increased strain.

In pneumothorax the danger of starting activity in the uncompressed lung is always present. The chief ways in which tuberculosis spreads in the lung are by the formation of metastases in tissue adjacent to the already existing foci through the lymph spaces, these metastases being favored by lessened motion and lymph stagnation; and by plugging bronchi with bacillus-bearing mucus, this being favored by deep inspiration and coughing. Increased motion favors this bronchogenic form of metastatic infection. Consequently, pneumothorax, which increases the inspiratory act of the noncompressed lung, favors the spread of infection in it. This is not an uncommon result in both spontaneous and induced pneumothorax where the lung, which is not collapsed, is the seat of secreting cavities. I have seen both good and harm follow a spontaneous pneumothorax, but have not found it followed by a high mortality. I have seen a few patients die within the first week, as a result of respiratory and circulatory embarrassment; a few more in three or four weeks as a result of infected pleura; others follow in much the same course as they would have followed had no pneumothorax occurred; and still others derive apparent benefit from it.

Effusion Into the Pleural Cavity.—Effusion occurs as a frequent complication of pneumothorax. The cause of the exudate, likewise the reason for its presence in some instances and absence in others is not known. It is usually thought to be due to the irritation produced by the presence of bacteria; but the fact that it occurs in induced, as well as spontaneous pneumothorax, shows that other causes must be operative. It seems possible that the change in intrapleural tension might be a factor to be considered, but I believe the separation of the pleural leaves which interferes with the normal absorption of fluid to be the greater factor. The pulmonary and costal pleuræ when in normal contact prevent the accumulation of serum. When separated, as they are in pneumothorax, the physiological absorptive mechanism is disturbed and the serum accumulates in the cavity. Lord[2] says: "Experiments on animals and observations on men have shown that air alone does not act as an irritant to the pleura, but since pneumothorax usually arises under conditions in which bacteria readily gain entrance to the pleura, it is only in exceptional instances, such as spontaneous pneumothorax or in rapidly fatal forms, that pleurisy fails to complicate the process." He further quotes approvingly the statistics of West[3] to the effect that the exudate is serous, seropurulent and purulent, each in about one-third of the cases.

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[2] Diseases of the Bronchi, Lungs and Pleura, Lea & Febiger, Philadelphia, 1915.

The serous exudate is not a serious complication and usually disappears partly or wholly in case of recovery. The other two forms, however, particularly the purulent, are extremely unfortunate and make the prognosis less favorable.

Recurrent Pneumothorax.—I have seen three patients who suffered from more than one attack of pneumothorax. Two had three and one had two. One patient who had three attacks was a physician in his early thirties. He was of robust build and had no symptoms of active tuberculosis. The ruptures occurred suddenly each time, when the patient was feeling well; and, being complete, always caused severe and alarming symptoms. I examined him after the third attack and found evidence of a slight tuberculous lesion in the apex of the lung on the side involved.

Another patient was a man aged sixty-five years. He had suffered at the time of his first attack, which occurred five years prior to the second, from a tuberculous involvement of the upper lobe of the right lung. The collapse at that time was complete and the patient was extremely ill. He was confined to bed for three months as a result of it.

The second attack came five years later, after the disease had spread and after dense pleural adhesions had formed. The patient was playing golf at the time. He experienced a feeling of shortness of breath and gave up the game. He called on a physician who gave him a heart tonic, thinking that the heart was the organ at fault. On examination the following day I found an area of hyperresonance over the lower portion of the right lung, and the mediastinum pushed to the left, when it was ordinarily to the right. The symptoms were so slight that it was necessary to keep the patient quiet for only a few days.

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[3] Lancet, London, 1887.

The third patient was one who was under my care in the sanatorium. He suffered from an extensive double lesion, with large areas of softening in the upper left.

The patient entered the sanatorium November 5, 1912, with a history of having suffered from active tuberculosis for one and a half years. At the time of entrance he had an extensive involvement of the left lung, with breaking down and cavity formation in the upper lobe, as well as the apex of the lower lobe. The right lung also had a moderately advanced lesion.

The disease ran an uneven course during the first six months with now and then a rise of temperature. At the end of this time the temperature became more regular and the symptoms began to abate. During the latter part of July, 1913, the temperature began to show a higher daily maximum and a wider diurnal variation. On the 6th of August, it suddenly went up to 103°. This was accompanied by increased cough and expectoration, with very little dyspnea. On examination the lower portion of the left lung was found collapsed. Owing to the dense adhesions the collapse did not extend beyond the third rib.

Following this pneumothorax the disease ran an uneven course for a few months and then the patient seemed to be much better. In the spring of 1914, after a period of many months during which the activity was lessening and the symptoms abating, the patient showed an unevenness in temperature. At certain periods it went high, but it was principally characterized by irregularity and occasional elevation. Beginning October 30th, Fig. 109, we find another very sharp rise of temperature. Where the daily variation had been from 98° in the morning to 99.5° in the afternoon, the temperature on the 31st reached 104°. It gradually dropped, but after a few days, on the 5th of November, the temperature attained 105°. The rise on the 31st was accompanied by pain in the left pleura in the fourth interspace near the heart, and increased cough and expectoration. The second rise on the 5th of November was accompanied by a marked reduction of expectoration, the total amount being reduced to one-fourth its original. There was no appreciable shortness of breath all this time. During the second attack the

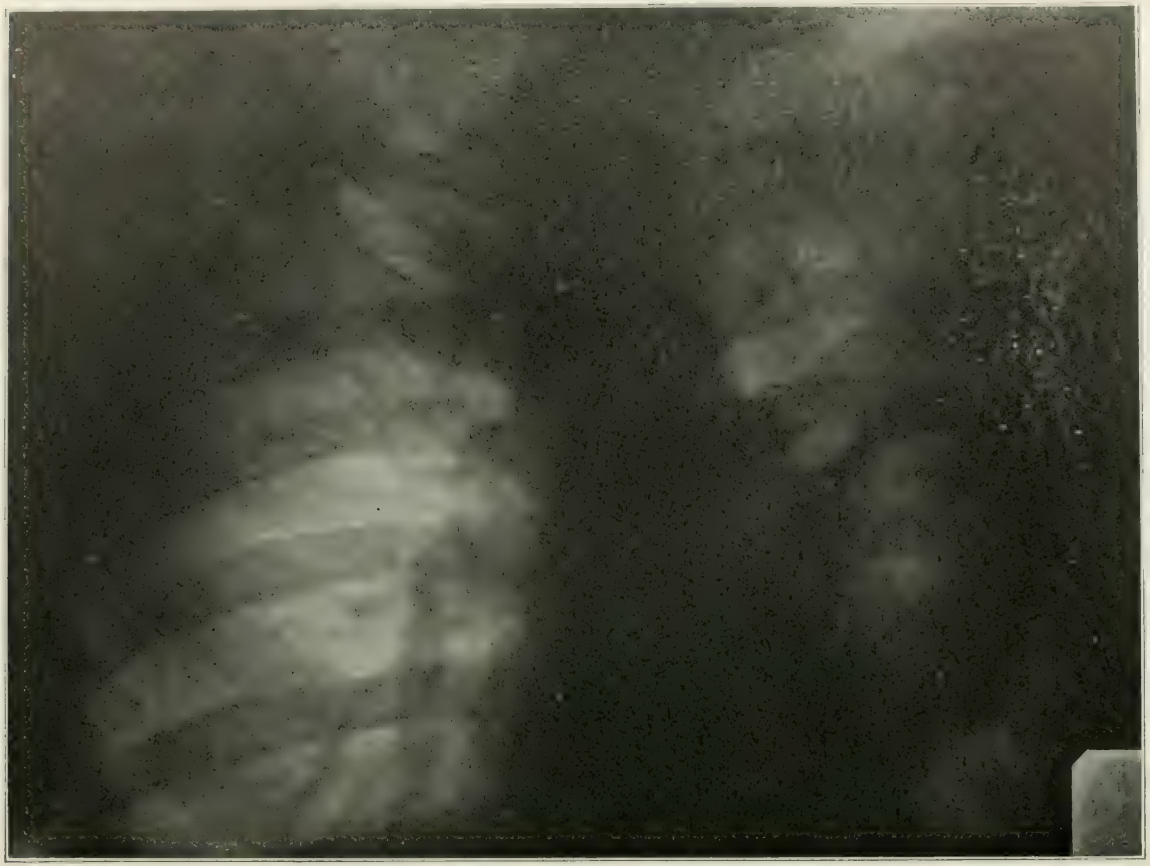

Fig. 111.—Showing an x-ray photograph of a chest which had experienced two previous attacks of pneumothorax. Patient subsequently suffered a third pneumothorax, and later went on to an arrestment.

patient was unconscious for several days. The marked rise beginning on the 30th and 31st was accompanied by increased cough and expectoration and pleural pain and was due to the rupture of a necrotic process near the pleura. Pneumothorax did not occur at this time. The reason that the temperature was so high was because of the absorption and the greatly increased cough. The marked rise on the 5th accompanied by marked decrease in expectoration was due to this focus opening into the pleura and thus producing pneumothorax. Following this pneumothorax the patient ran an uneven course and gradually improved; however, no definite improvement could be ascribed to the pneumothorax itself. In December, 1915, he had an attack of influenza, which was followed by a third pneumothorax. Following this he ran an elevated temperature for several months and then attained an arrestment of his disease. Fig. 111 is an x-ray picture of this patient's chest prior to his last pneumothorax.

Treatment.—The treatment of pneumothorax consists in meeting conditions as they arise. If the symptoms are severe and the heart is badly embarrassed, I use morphine ¼ gr. hypodermically as often as required. This relieves the nervousness, supports the heart and quiets the cough. I have the patient assume the recumbent posture and do not allow him to get up or exert himself in any manner until the acute stage has passed. This spares the heart avoidable strain and prevents the coughing which would be brought on by exertion. The heart may require digitalis.

When the symptoms are not so severe, I enjoin rest, as above, but give codeine or heroin, instead of morphia, to check cough.

The bowels should be kept open with some such remedy as castor oil or salines. The diet should be light but nourishing, until the digestive organs improve in tone; milk, buttermilk, or milk modified by Eskay's Food, Mellin's Food, or Malted Milk, eggs, gruels and other such foods may be used, followed later by a generous and varied diet, as soon as the intestinal tract will tolerate it.

In the valvular form of pneumothorax the intrapleural pressure at times becomes so severe that suffocation will follow unless relief is afforded. This is given by inserting a trocar and allowing the air to escape.

CHAPTER XXVII.

TUBERCULOUS MENINGITIS.

Tuberculous meningitis may result from either hematogenic or lymphogenic infection. When infection takes place through the lymph it is usually an extension from tuberculosis of the middle ear or vertebra. When infection occurs through the blood it may come from an infection in any part of the body, the previous focus being in the lung; or in the lymph glands, mediastinal, mesenteric, or cervical; in the kidney; bones; in fact, in any tissue. It is also possible that the primary point of infection might be the meninges, as would occur from bacilli passing through the intestinal wall, being taken up by the lacteals and poured into the thoracic duct, thence into the blood stream, to be screened out in the meninges. A spinal meningitis may also occur as a direct extension from tuberculosis of a vertebra. Tuberculous meningitis, as a rule, assumes the form of miliary nodules accompanied by collateral exudative inflammation.

The course of the disease depends considerably on the extent of the involvement and the amount of exudation present. It may be a slowly developing chronic disease, or it may be acute, running its course in a very short time. As a rule, it takes a very acute course. Healing undoubtedly occurs at times. Especially is this true if the tubercles are few in number. We should expect a healing of solitary tubercles in the meninges the same as in other structures of the body. The location of the infection is most common at the base, and is spoken of as a basilar meningitis; or it may extend along the adjoining fissures; or form nodules in the dura mater, and even in the adjoining substance of the brain itself.

Many times the ventricles are filled with exudate, particularly the lateral ventricles, and the pressure, at times, greatly enlarges the cavities. The exudate which is found may be serous, sero-fibrinous, fibrinous, or purulent in character. A large quantity of lymphocytes are often found in the exudate. At times, as a result of the tuberculous process, the superficial brain substance softens, producing a genuine encephalitis.

Aside from the miliary tubercles just mentioned, we sometimes find solitary tubercles in the brain substance; and, again, we find tuberculous infiltrations and ulcerations extending into the brain substance from the dura.

McCarthy[1] has described several such cases. One of this character came under my own observation. In this case there were severe ulcerations along the longitudinal fissure, varying in size from 1 to 2½ cm. in diameter, and extending into the brain substance for about ½ cm.

Symptomatology.—The course of the disease in different patients varies greatly. The onset does not seem to follow any set rule. My experience has been almost wholly confined to meningitis as a complication of pulmonary tuberculosis, and most of the patients have been under my observation for a considerable period prior to the onset of the meningeal infection. The symptoms vary according to whether many or few tubercles are present, and whether or not they are accompanied by marked collateral exudation.

Nervous System.—One of the early symptoms of meningitis in many cases is that of irritability. This sometimes comes on several weeks preceding the frank symptoms.

Later in the disease the patients often have convulsions and still later lapse into unconsciousness. This may occur shortly prior to death, or, the patient may lie unconscious for a number of days.

Headache is a symptom which is present in nearly all instances. It may affect any part of the head; but, in my experience, it has seemed to be most marked at the base, although frontal headache has been quite common. This headache is usually influenced by motion.

Fever.—Fever is extremely variable. Bonney has seen patients without any rise of temperature. I have seen some where the temperature was elevated only a degree; in fact, the usual temperature is 100° and 101°, although it may go as high as 103°.

Pulse.—The pulse is influenced by the intracranial pressure. There are several symptoms in tuberculous meningitis which are due to vagus irritation, noticeably a slowing of the pulse, vomiting, and irregular respiration,—sometimes of the Cheyne-Stokes character. The pulse does not always show this vagus influence. Sometimes, particularly early in the disease, the pulse is rapid. It may again become rapid later in the disease, but there is often a distinct slowing of it during some period of the infection.

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[1] Second Annual Report of the Henry Phipps Institute, Philadelphia, 1906.

Muscle Rigidity.—Muscle rigidity is a common symptom, although it may be absent. In children it is often present to so high a degree that the neck is drawn backward producing the characteristic opisthotonos. This action is due to the irritation of the spinal accessory and cervical nerves.

Gastrointestinal Tract.—Nausea and vomiting are prominent symptoms, being present in some 80 per cent of cases. In one case under my care an old chronically-inflamed appendix was present. The symptoms of nausea and vomiting were so pronounced at the beginning of the attack that we feared a fulminating appendix. To add to our deception in this case there was some pain over the abdomen. The diagnosis, however, was cleared up on the second day when headache and other symptoms manifested themselves. Constipation is commonly present and, at times, is extremely obstinate.

Ocular Symptoms.—Disturbances on the part of the eye are common. A mild ptosis, sometimes unilateral, sometimes bilateral; divergent and convergent strabismus; and nystagmus, are occasionally present. The pupil shows many variations. There may be a sluggish reaction to light; a dilatation; an extreme contraction; or, a general instability. In connection with dilatation of the pupil it is well to remember that this is common in pulmonary tuberculosis as a result of irritation of the upper dorsal sympathetic fibers; consequently this sign alone is of no value in the presence of a pulmonary lesion. An examination of the eye grounds often shows papillitis present,—a sign of great diagnostic value.

Kernig's Sign.—This is usually present, and may be elicited by allowing the patient to lie in bed on the side or back, or by allowing him to sit on the edge of the bed with feet hanging on the side. The thigh must be at a right angle with the body and the leg must be flexed. When meningitis is present an attempt to extend the leg upon the knee is met with rigidity which makes it difficult or impossible to accomplish. This is due to a flexor contracture of the ham-string muscles.

Diagnosis.—The diagnosis is not difficult to make after the major symptoms appear; but earlier, during the period of nerve irritation, the meningeal cause may not be suspected. When such pressure symptoms as headache and vomiting appear, then the cause is usually quite distinct. If the pathology is borne in mind, and the fact that nearly all symptoms are due to pressure, diagnosis of the disease will not be so difficult. Examination of the eye grounds is of great importance. In those cases which come on in patients suffering from pulmonary tuberculosis, or other known lesions, the tuberculous element should be suspected. Where it comes on suddenly, however, in a person previously in good health, it is quite difficult to determine whether the meningitis is of a tuberculous or non-tuberculous nature. Examination of the spinal fluid will sometimes give important information. In the case of tuberculous meningitis it is usually clear or slightly turbid; while, in the non-tuberculous infections, it is apt to be purulent.

In quite a large percentage of patients in the last stage of the disease tubercle bacilli may be found in the fluid. Earlier, however, they are not commonly found.

Where bacilli are not found a high lymphocyte count points toward the possibility of tuberculosis, while a high polynuclear is found more commonly in non-tuberculous infections.

Treatment.—The treatment of tuberculous meningitis consists in making the patient comfortable. As a rule little can be done with hope of more than temporary improvement. Bromide is a splendid remedy for relieving headache and quieting nervousness. Ice to the head is also of value in relieving headache. Constipation must be relieved by proper laxatives. Calomel, either plain, or in the compound cathartic pill is valuable. When pressure symptoms become marked, they may be relieved by lumbar puncture, drawing off from one to one and a half ounces of fluid. This relief of pressure is often followed by a return to consciousness and a diminution of headache.

This dread complication is nearly always fatal, although we now and then see reports of cases which have been diagnosed

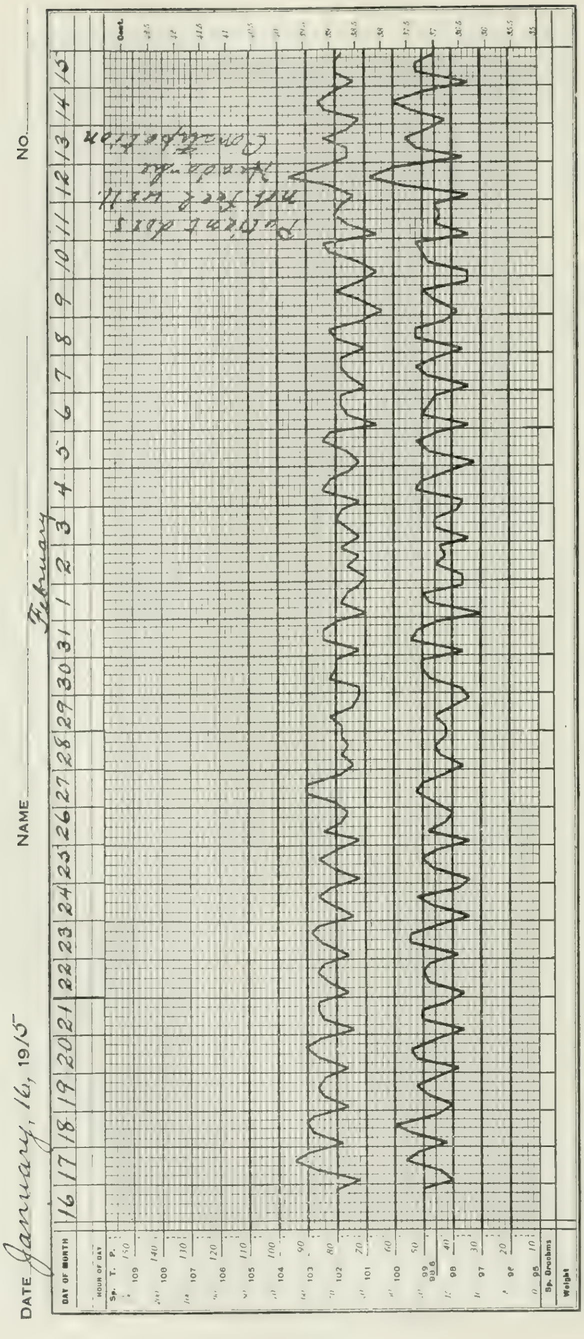

Fig. 112*A*.—Showing the engrafting of a meningitis on a slightly active moderately extensive pulmonary lesion. The meningitis begins to show in the chart on the 12th of February. Upper curve, pulse; lower curve, temperature.

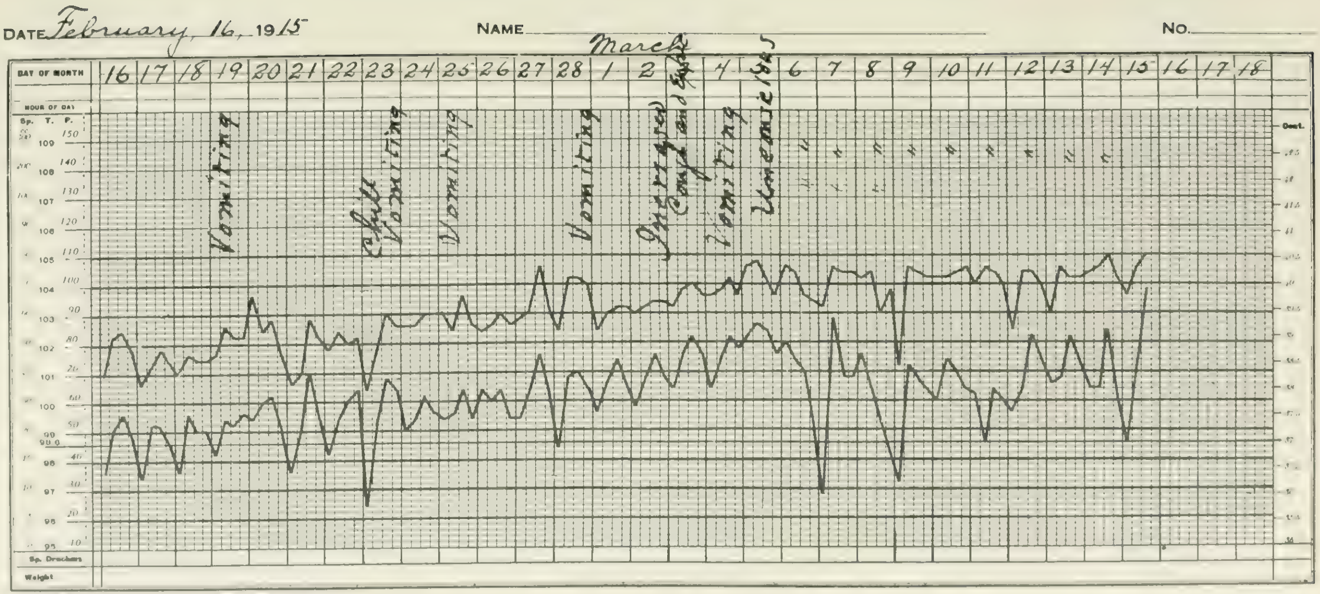

Fig. 112B.—Showing the engrafting of a meningitis on a slightly active moderately extensive pulmonary lesion. The meningitis begins to show in the chart (Fig. 112A) on the 12th of February. Upper curve, pulse; lower curve, temperature.

as such and which have healed. It is not beyond reason to suppose that slight meningeal affections heal occasionally. Postmortem evidences are now and then found which prove this to be a fact; yet such are the exceptions. The diagnosis is rarely made until the disease is thoroughly established. It might be if we could make our diagnosis at the time when the first tubercles form on the meninges that aid might be brought to some of the limited infections. After the disease develops fully we often see that the symptoms appeared weeks before. If we are ever to make much headway against this infection, however, it would seem that it would be necessary to have a remedy capable of destroying the bacilli; and introduce it into the spinal canal, for it has been demonstrated that the spinal fluid carries very few immune bodies. While the meninges are well protected by their situation, they seem to be correspondingly poorly protected by the fluid which bathes them. Tuberculin is of little value in this complication. It works too slowly to offer assistance.

Fig. 112, *A* and *B,* is instructive in that it illustrates the development of tuberculous meningitis in a patient who had suffered from chronic clinical pulmonary tuberculosis for a period of two years. The disease was moderately widespread, involving the greater portion of the upper lobes on both sides, and the upper portion of the lower lobe on the right. The process was largely fibroid in character although it had recently taken upon itself a more active form with considerable softening.

During the first few weeks that the patient was under treatment, improvement seemed to be very satisfactory. All of the more prominent symptoms lessened in severity. On the 11th of February without any previous indications the patient complained of not being so well. He had a slight headache most marked at the base. This was followed by constipation. The temperature following this began to reach a higher maximum than on preceding days. This was not marked, however, until after the 20th. The pulse at first increased with the temperature but during the last few days, if the temperature had been taken by mouth the same as that shown in the rest of the chart, a disproportion between the two (the pulse being relatively slow) would have been evident. From the 5th of March until death the temperature record was taken in the axilla owing to the fact that the patient was unconscious; consequently the temperature record is lower than it should be.

On the 19th of February the patient began vomiting and this continued occasionally until the end. During the last ten days of life, the patient was unconscious most of the time.

CHAPTER XXVIII.

TUBERCULOSIS OF THE GENITOURINARY SYSTEM.

Kidney.—Tuberculosis of the kidney is a common complication in patients suffering from advanced pulmonary tuberculosis. However, it produces symptoms in a comparatively small percentage of cases. In most instances it is found postmortem, without having been suspected during life. I can conceive of tuberculosis being primary in the kidney; but, I would not expect to find it frequently so. Bacilli could pass through the mucous membranes of the intestinal tract, find their way into the thoracic duct, thence into the blood stream, and, after passing through the lung, be strained out in the kidney. In this way, we could have a primary tuberculosis of the kidney, but it is far more common to have the tubercle bacilli come from some other focus within the body. It is not necessary that this be in the lung. It could be in the glands or any other structures. In tuberculosis of the lungs, however, we must conceive of a more or less frequent escape of bacilli into the blood stream, consequently the danger of other organs becoming infected. The fact that other organs are not more commonly infected must be accounted for by the unusually high degree of specific resistance attained on the part of the tissue cells when tuberculosis has been present in the system for a prolonged period of time.

The studies of Joseph Walsh[1] showed positive tubercles present in the kidneys in 58 per cent of sixty cases examined. In addition there were three other specimens which showed ''an accumulation of round cells, resembling young tubercles, which were questionable.'' With these included there were thirty-eight cases, out of sixty, or 63 per cent which showed definite tuberculosis in the kidney. Inoculation experiments showed tubercle bacilli in the urine in 82.5 per cent of urines inoculated. This indicates fairly the amount of infection that is present in the kidneys in cases dying of tuberculosis; or suggests that bacilli might be excreted through the kidneys.

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[1] The Kidneys in Tuberculosis, Second Annual Report of Henry Phipps Institute, 1905.

Another very interesting thing in this report is the fact that definite healing was shown in several instances which makes the author say: "A tendency toward healing seems at least as great in the kidney as in other organs." This is so different from the usual teachings that it is well to emphasize it.

Many writers take the view that tuberculosis of the kidney shows no tendency to heal. I can see no reason why miliary tuberculosis of the cortex of the kidney should not heal as readily as tuberculosis elsewhere. It is evident, however, that tuberculosis of the calyx, because of the character of the tissue in which the lesion is located, and because of the fact that it is constantly bathed in urine, is surrounded by conditions unfavorable for scar tissue formation.

The parenchyma of the kidney is usually affected first, tuberculosis being found beneath the capsule, and from here the disease usually spreads toward the pyramids, pelvis, ureter, and bladder. The process may spread rapidly, or it may remain localized at the point of inoculation. Here as in other tissues, the tubercles coalesce and the tuberculous mass increases in size until necrosis and caseation, with rupture and the formation of abcess cavity results.

The infection may be confined to one kidney, or it may extend to both. From the general tendency of the disease to spread through the blood stream, it is extremely important to be able to tell clinically, if possible, whether one or both kidneys are involved. Particularly is this true in this day when the preponderance of opinion favors immediate removal upon diagnosis, a teaching which should be discussed further before adoption.

Symptomatology of Tuberculosis of the Kidney.—Tuberculosis of the kidney usually develops slowly and its symptomatology depends largely upon the location of the tubercles. If they are confined to the parenchyma a widespread lesion may be present, without giving symptoms in keeping with the seriousness of the trouble. On the other hand, if the pelvis is involved, signs usually appear to make the disease more readily recognizable. Oftentimes we are led to believe that the disease has been present for a long time prior to the time of examination. Pain is the symptom which commonly sends the patient to the physician; and, inasmuch as this is not a universal symptom, and, since it comes late in many cases, it cannot be relied upon for early diagnosis. The patient often fails to consult a physician until the disease is advanced. It is quite often that the bladder becomes infected before the physician is consulted. If there is painful, or frequent micturition, this may cause the patient to seek relief. When the pelvis of the kidney is involved the urine usually contains pus, and, occasionally, blood; consequently, it often has a cloudy appearance. The urine in the early case, instead of being cloudy, is often light in color and of very low specific gravity. Polyuria is one of the early symptoms of tuberculosis of the kidney. When pain is present, it may be felt over the kidney, along the urethra, and occasionally, may take the form of renal colic. Reflex pain may be felt in the testicle or thigh.

The demonstration of tubercle bacilli in the urine is not easy. Sometimes a marked lesion is present and no bacilli are found. The entire twenty-four hour sample should be taken and centrifuged for a long time before examination. The absence of bacilli should not have much influence upon the diagnosis. At the present time, when the immediate operative treatment of tuberculosis of the kidney is so common, it is very important that tuberculosis of the other kidney be excluded before one is removed; and the difficulty of being sure that the other kidney is not involved, is not generally appreciated.

Catheterization of the kidney and examination of the urine may, or may not, give evidence. As mentioned above, if the parenchyma of the kidney is involved, the urine may show negative signs and yet a serious involvement may exist.

I desire to call attention to the spasm of the lumbar muscles as being an important sign in the diagnosis of inflammation of the kidney.[2]

As mentioned elsewhere in these pages, the afferent impulses travel from the internal viscera to the cord and manifest themselves in the skeletal muscles, producing reflex contraction dur-

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[2] Pottenger: Spasm of the Lumbar Muscles, a Diagnostic Sign in Inflammation of the Kidney, Journal American Medical Association, March 29, 1913, vol. lx.

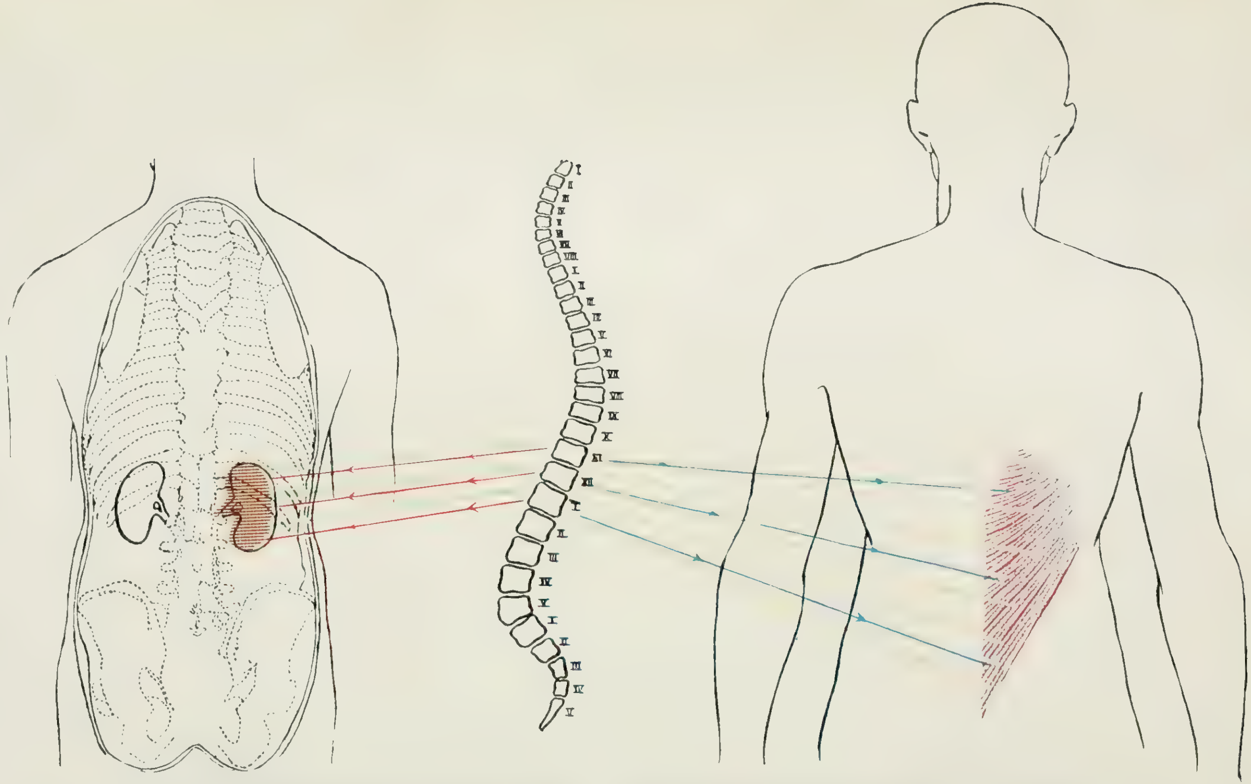

Plate X.—Showing Schematically the Sensory and Motor Reflexes when the Kidney is Inflamed.

The *red lines* represent the sympathetic innervation of the kidney which is derived from the XIth and XIIth thoracic, and Ist dorsal segments of the cord. The *green lines* indicate the sensory impulses carried by the sympathetic nerves to the same segments (XIth and XIIth thoracic, and Ist dorsal) when the kidney is the seat of inflammation. The *yellow lines* represent the spinal motor nerves completing the reflex and carrying the impulses to the lumbar muscles which are thrown in spasm during acute inflammation and degenerated when the inflammation is chronic. The *blue lines* represent the spinal sensory nerves which complete the reflex and produce altered cutaneous sensation (pain) in the lumbar region when the kidney is inflamed. The *arrows* indicate the direction in which impulses travel.

ing activity, and degeneration when the disease becomes chronic. The kidney is supplied by sympathetic nerves which take their origin from and communicate by rami communicantes with segments from the sixth thoracic to the first lumbar. The larger number of filaments to the kidney arise from the eleventh and twelfth thoracic and first lumbar segments.

The reflex on the part of the kidney expresses itself in spasm of the lumbar muscles on the side of involvement. Spasm, when present, is best detected by placing the patient on a comfortable stool or chair so that his feet are flat on the floor. He is then instructed to sit erect in such a manner as to relax the lumbar muscles, relaxation being essential to determining the presence of reflex increased tone. The muscles are then examined by light touch palpation. Any difference in tension should be noted. When one kidney is the seat of an inflammatory process, the muscles on that side will be firmer than normal. If both kidneys are inflamed the muscles on both sides will show increased tone. On account of there being no normal muscle for comparison, the diagnosis is not so easy to make, when the involvement is bilateral. Sometimes the degree of tension is so great that it can be determined by inspection as well as palpation. The muscles can be seen to stand out on the infected side more prominently than on the opposite side. The paths of motor and sensory impulses in the kidney reflex are shown in Plate X.

The importance of this sign is evident. I have used it to great advantage in many cases.

Where the kidney is to be removed because of a tuberculous lesion, the muscles on the other side should always be examined for spasm before operation is done.

The examination of urine taken by catheterizing the ureter may or may not prove the presence or absence of tuberculosis of the kidney from which the urine comes. The fact that no evidences are found should never be considered as conclusive, because all forms of tuberculosis are irregular in their course, the symptoms at times being more pronounced, and then, again being slight or absent. The injection of guinea pigs may also be inconclusive. In fact, we cannot rely wholly for the presence or absence of infection in a given organ upon any of the methods at our command. I, personally, would rely more upon the condition of the muscles than any other one individual factor; but would make up my mind from the whole picture rather than any one phase of it. The tuberculin test is of no value unless it produces focal stimulation of the kidney, followed by pain, hematuria, or an increase in the general urinary findings; but this must not be expected to occur either regularly or often, unless large doses are administered.

Treatment.—The writer has treated numbers of cases of tuberculosis of the kidney conservatively. By conservative treatment I mean the usual measures which are used for the treatment of tuberculosis, including tuberculin. I have been pleased to note a diminution of symptoms, and, not infrequently, a clinical healing. In one case of bilateral tuberculosis of the kidney, treated six years ago, a clinical healing was obtained and the result has remained favorable so far.

McGowan and Dillingham both report splendid results in the treatment of tuberculosis of the kidney. Dillingham[3] uses tuberculin in small doses. The preparations used by him were O. T. and B. E. He says:

"In the average case 1-75,000 mgm. was given twice a week and so gradually increased that there was never a local or general reaction. In those cases complicated by lung infections this initial dose was reduced to 1-350,000 mgm."

The writer has treated his tuberculosis of the kidney only as this infection complicated the pulmonary lesion, and has used his doses of tuberculin in the same manner that he has used it in treating his pulmonary cases generally, and consequently, has used much larger doses than those mentioned by Dillingham (see Chapter XL).

There is no doubt that tuberculosis of the kidney will, at times, heal; and there is likewise no doubt that the patient is much better off with two imperfect kidneys than with one imperfect one; or with one kidney that is able to functionate well and one that is able to functionate imperfectly, rather than one organ, so it would seem to me that, unless the lesion is advanced and producing dangerous symptoms, conservative measures should always be tried before the organ is removed.

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[3] A Report of Fifty Cases of Tuberculosis of the Kidney and Bladder Clinically Cured Without Operation. Read before the California State Medical Society, April, 1916.

Tuberculosis of the Bladder.—Tuberculosis of the bladder, as a rule, results as an extension from the kidney or epididymis. In every case of tuberculosis of the bladder the kidney must be suspected and thoroughly investigated. Ulcerations, as a general rule, start near the mouth of the ureter on the side of the diseased kidney, and the diagnosis is quite readily made by the cystoscopic examination. The tubercles, however, may spread to any portion of the bladder and in some instances are found very widely distributed. The symptoms are those of cystitis. The infection usually begins with slight urethral irritation and increased and frequent urination; but as the disease progresses, pain becomes an important symptom. In severe cases the bladder may become so intolerant that it cannot contain more than a few drams of urine at a time. As a result, the patient may be compelled to pass urine so frequently that his sleep and rest are constantly interfered with which, together with the pain, makes a very severe tax upon his vitality.

The diagnosis is made by the symptomatology and may be confirmed by the cystoscope. The existence of tuberculosis in the lung, or in some other portion of the genitourinary tract aids in making the diagnosis.

In treatment of tuberculosis of the bladder, both general and local measures should be employed. The latter consist in irrigating the bladder by various substances, curetment, and, in some instances, cauterization. Simple measures, however, are to be preferred to the harsher ones.

It seems to me that greater experience in tuberculosis shows that it is a disease that has a tendency to heal, no matter where the lesion is located; so, if we can raise the patient's resisting power by the various methods used for the treatment of tuberculosis in general, give him the stimulation afforded by tuberculin and use such local measures as will allay irritation, and afford rest, we are working along the right line.

Dillingham, in the paper above referred to, reports excellent results by the use of general hygienic measures, tuberculin, and the irrigation of the bladder with silver nitrate. He says the progress

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seems much better where some form of cleansing irrigation for the bladder is used. In some cases he recommends the use of gomenol or argyrol. He cautions that silver nitrate should not be used in too concentrated form and says:

> ''I begin with a pint of a 1/50,000 solution in distilled water and frequently find that this is too strong, the rule being not to cause irritation either from the strength of the silver or the rapidity of the injection; and when it is safe to begin to stretch the bladder, I do not stretch it more than once or twice at a sitting and am guided by symptoms whether to repeat it at the next visit or to rest for one or two visits. In increasing the strength of the silver, which is done as rapidly as possible, the bladder should never burn,—it is permissible for them to have a slight feeling of warmth for a few minutes but it should not burn or cause distress and the majority remark that it makes them feel easier and relieves their irritation to have the bladder washed. Some patients have complained of having had silver nitrate used in so strong a solution by other physicians that their bladder burned intensely for more than an hour and that often this condition would be followed by blood and great tenesmus, and their general condition would be made much worse.''

Tuberculosis of the Testicles.—Tuberculosis of the testicles occurs occasionally in the course of tuberculosis of the lungs. In fact it may follow tuberculosis in any other portion of the body. It is occasionally thought to be primary. The disease, as a rule, is found in the epididymis, rather than in the body of the testicle itself. However, occasionally, the body of the testicle itself may be the seat of the primary metastasis. The disease usually develops slowly and painlessly and may reach quite an advanced stage before being discovered. The organ usually enlarges in size and frequently the infection is noted by the discovery of hard nodules in the gland. At times these caseate and break down. At other times they may remain quiescent or may heal without going on to the formation of pus. In quite a large percentage of cases, varying from 50 to 75 per cent, there is an extension to the opposite side.

Tuberculosis is differentiated from syphilis by the fact that tuberculosis usually begins in the epididymis, while syphilis begins in the body of the testicle; but, inasmuch as this is not always true, it cannot be considered as a positive point in diagnosis.

The treatment is that of the general treatment of tuberculosis. Whether the organ shall be removed or not depends wholly upon the circumstances. Conservative measures should always be used first and persisted in for months unless the condition is such as to demand immediate operative interference.

Tuberculosis of the Seminal Vesicles, Prostate, Ovary, and Tubes.—All of these organs are sometimes the seat of tuberculous infection, and when so involved should receive the usual treatment directed to tuberculosis.

From tuberculosis in the tubes, the process may extend into the peritoneum, and in this way a tuberculous peritonitis may result. The desirability of operation on these organs which are removable will bear considerable consideration. A study of the recommendations met in treatment show that the removal of the organs of the female are recommended much more often than those of the male. It must be remembered in this respect that diseases of the organs of generation have a tendency to produce mental depression. Removal of them often has a greater depressing effect than the disease itself. With the hope that modern therapy offers for treatment I would advise a trial of conservative measures in all instances.

In one case of tuberculosis of the ovary where the patient refused operation, the other organ having been removed at a previous time, we secured a healing after it had shown very marked pathological change. This patient was treated eleven or twelve years ago, and has shown no signs of recurrence.

CHAPTER XXIX.

OTHER NON-PULMONARY TUBERCULOUS COMPLICATIONS.—TONGUE, TONSIL, PHARYNX, EAR, BONES AND JOINTS.

During the course of pulmonary tuberculosis, also occasionally as an independent infection, we find a tuberculous complication involving such organs as the tongue, tonsils, and pharynx, and quite frequently, particularly during childhood, we find the bones and joints involved. It is unnecessary to treat the disease as it manifests itself in these structures *in extenso* in this place, because its therapy depends upon the general principles laid down elsewhere in these pages. The disease differs only in that it involves different tissues.

Tongue.—As discussed in the chapter on pathology, I called attention to the fact that tuberculosis of the tongue appears now and then as a complication of pulmonary tuberculosis. In most of the cases which I have seen, the relationship between the tuberculous involvement and trauma was not plain; in a few, however, it could be definitely determined. In one or two instances, tuberculosis of the tongue followed an injury by biting. In another instance infection took place in a cut made by drawing the tongue over the front teeth preparatory to laryngeal treatment. The tongue, being muscular tissue, is not prone to tuberculous infection.

The prognosis in tuberculosis of the tongue depends upon the character of the tuberculous process in general. If the patient is suffering from a general tuberculosis which will yield to therapy, the tongue will heal, too. If, on the other hand, the pulmonary process is acute, with caseation and necrosis predominating there is little chance of the infection in the tongue healing. My experience has shown that, as a rule, tuberculosis of the tongue heals slowly. In two of my cases healing was completed only after nine or ten months of treatment. In one, two years and a half was required to overcome the ulceration. The process, as a rule, takes upon itself the proliferative type; and the ulceration is, for the most part, clean and free from purulent discharge. When the ulceration involves the apex of the tongue, as it did in two of my cases, healing is extremely difficult to bring about. There is a tendency with different motions of the tongue, for the muscular fibers of the tip to separate. This keeps the ulceration open.

Treatment.—Experience in treating tuberculosis of the tongue will convince anyone that local applications are futile. I have never seen any direct influence result from local applications of stimulating or antiseptic remedies, although I have given them a fair trial. Healing must come about, the same as all healing in tuberculosis, through raising the patient's resisting power by means of the many measures which are directed toward that end and by stimulating fibrosis by the use of tuberculin. Tuberculosis of the tongue is shown in Figs. 11*A*, *B*, and *C*, Volume I, page 46.

Tonsil.—Tuberculosis of the tonsil is an infrequent complication of pulmonary tuberculosis, or tuberculosis anywhere in the body. Tubercle bacilli may be found by inoculation experiment in about 20 per cent of tonsils removed from children. This does not mean, however, that a tuberculous infection of the tonsil exists. This is an extremely uncommon infection. In my experience in tuberculosis I have met with less than half a dozen cases of tuberculosis of the tonsil. I have never seen an infection of this organ heal. In the cases that I have seen, it has come on as an end result, not appearing until a short time prior to the death of the patient. The treatment in no way differs from that of tuberculosis anywhere else in the body.

Pharynx.—Tuberculosis of the pharynx may result from direct infection of the pharyngeal tissue or by the tubercle bacilli coming from adjacent structures. I have seen numerous cases of tuberculosis of the pharynx, only one of which resulted in healing. If tuberculosis of the pharynx is widespread it involves the muscles of deglutition and makes swallowing very painful. The result is, that when the patient has such an involvement the process becomes so painful that the patient will risk the chances of starvation and ultimate loss of life rather than make the continued effort necessary for eating. Here, again, the treatment consists of the general treatment of tuberculosis. Local applications should be used, however, as they will keep the parts clean and render sufficient anesthesia to make the patient comfortable. An alkaline spray will usually be useful. Menthol in olive oil, from 2 to 4 per cent, may be used as a gargle by those patients who do not object to the taste of the oil. I have found this very useful in many instances. Inhalations of anesthesin in some such formulas as are recommended by Lockard, are useful (see page 30).

Tuberculosis of the Ear.—This is found uncommonly as a complication of pulmonary tuberculosis. It is also now and then found as an independent infection. It is usually recognized as a suppurative process and very often when the physician is consulted the tympanic membrane will be already ruptured. It is characteristic of the tuberculous ear to show alternate periods of activity and quiescence. Oftentimes, the diagnosis is not suspected until the patient is shown to have a pulmonary disease. As a rule, the course shows a marked absence of pain.

Such local therapeutic measures should be used as have a tendency to keep it clean. A free exit for drainage should be maintained. Antiseptic powders may be used at times to advantage. Boracic acid 2 per cent in alcohol, or iodoform 2 to 10 per cent in alcohol may be dropped into the ear, to be followed by washing with hot water. This measure at times seems to aid in keeping the ear clean; but we should not expect any active curative influence to be exerted by these local measures. Now and then a tuberculosis of the ear will, by extension, produce tuberculous meningitis, resulting in death.

Bones and Joints.—It is not my purpose to treat of tuberculosis of the bones and joints extensively. Infections of this kind have heretofore been given over almost exclusively to the surgeon, but I wish to emphasize the fact that tuberculosis of the bones and joints is also a medical disease. The conservative treatment of these structures is gradually gaining adherents. Great impetus has been given this recently through the work of Rollier, who has been so successful in the application of heliotherapy to these infections. It is remarkable what intelligent treatment will do for many conditions which were heretofore considered serious. It seems to me that the great point to remember is that we are dealing with structures that have a tendency to undergo healing if intelligently managed. Intelligent management means the use of all remedies or measures that will help to heal the disease and restore function. During recent years many measures have been instituted, but, as a rule, workers are apt to forget the many-sided nature of tuberculosis and rely on one or two measures to the exclusion of others. Hyperemia will produce excellent results in many cases of tuberculosis of the bones and joints; but hyperemia should not be relied upon to cure tuberculosis. Heliotherapy will produce excellent results, but it is not all that can be done. Many orthopedic measures, including rest and splints, will produce results that are fairly satisfactory, yet no one today would rely upon them wholly.

The principles which underlie the treatment of tuberculosis, as described in Chapter XXXIV, point the way to the intelligent handling of tuberculosis wherever found. Tuberculosis of the joints should be treated by rest, splints, heliotherapy, hyperemia, tuberculin, and all of the efficacious tonic measures which are applicable to tuberculosis of the lungs. We must not expect rapid cures, no matter what the remedy used. Time alone will produce satisfactory healing of a tuberculous lesion, no matter in what tissue it is situated.

CHAPTER XXX.

FEVER IN TUBERCULOSIS.

What is Meant by Fever.—At the outset of this discussion I wish to make it clear that the fever of tuberculosis, the same as that of any infectious disease, is not an entity, but a part of the syndrome of central plus sympathetic stimulation; and, as such, is caused by both an increase in metabolic activity and a decrease in heat elimination, the latter being produced by the action of the toxins upon the sympathetic nervous system. The particular effect of the sympathetic stimulation is exerted upon the vasomotor system and interferes with the principal path of heat elimination as I shall discuss later.

There are other conditions met in tuberculosis, besides the toxemia, which are accompanied by a rise in temperature, such as the depressive emotions, disturbances in some of the internal secretions, and rises in atmospheric temperature; but these are not an integral part of the disease. These conditions will also be discussed in this chapter. Any factor which stimulates and prolongs vasoconstriction of the skin vessels will cause a rise in temperature by interfering with heat elimination. This will take place whether there be increased heat production or not.

Fever is a condition in which the temperature of the body is above normal. It is accompanied by disturbed function on the part of the body cells,—the degree of disturbance keeping pace, to a certain extent, with the degree of rise above normal. An acute rise of temperature is accompanied by symptoms more marked and more serious than the chronic form.

By fever, we do not understand a rise of temperature above 98.6° F. (mouth measurement), but we mean a rise above normal for the time of day that the temperature is measured. The misconception is very common that the patient's normal temperature is always 98.6°. This is untrue. There is a normal diurnal variation of about one and a half degrees, which marks the natural ebb and flow of body heat (Fig. 113, page 126). The temperature reaches its lowest point sometime in the early morning hours which, in a normal individual, would be 97.2° or 97.4°; and it reaches its maximum sometime in the afternoon, probably about two or four o'clock, which should be about 98.6°. The time of day when the minimum and maximum temperatures appear varies with different individuals and according to the body activities. The minimum may be at two or three, or as late as six or seven in the morning. Likewise the maximum may be as early as ten in the forenoon, or as late as the middle of the night, or any hour between; but, it is safe to say, under ordinary circumstances, that a temperature of 97.2° or 97.4° in the early morning is normal for that hour of the day, and 98.6° measured at two or four o'clock in the afternoon is likewise normal for that hour. Any departure from this should call for analysis to determine the cause.

The diurnal variation in fever may, or may not, be the same as the diurnal variation in the normal temperature curve. It may vary about a degree or a little over; or, it may vary several degrees. I have seen this variation amount to ten degrees in one instance in tuberculosis.

It should be known that the normal individual may have a rise of temperature considerably above 98.6° during exercise. A temperature of 100° and 102° is commonly found after violent exercise. It is said that the workers in the tin mines of Cornwall, England, who work out under the ocean under conditions decidedly unfavorable from the standpoint of ventilation, work with body temperatures several degrees above normal. Violent athletic exercise and work even in the open air are followed by a rise in body heat often of several degrees.

The maximum and minimum temperature keeps pace with body activities; consequently, it may be reversed in patients who work at night and sleep during the day. Tuberculous patients, suffering from fever, who are awakened in the early morning by severe paroxysms of coughing may, at times, show their maximum temperatures in the early forenoon, the rise being hastened by the extra heat production which results from the muscular exertion required in coughing.

The following group of symptoms, with a few variations, was published in a former paper.[1] They are those which accompany fever and are due to toxemia:

Malaise.
Lack of endurance.
Loss of strength.
Nervous instability.
Headache.
General aching.
Chilliness or rigor.
Lack of appetite.
Digestive disturbances.
Loss of weight.
Rapid heart's action.
Night sweats.
Fever.
Blood changes.

When toxemia is very severe, producing collapse there results:

Vasodilatation (vasomotor paralysis).
Sweating.
Subnormal temperature.

These manifest themselves in a syndrome which represents a general nervous discharge through the sympathetic system. That some of these symptoms are partly due to central nerve irritation and exhaustion is also evident; for example, malaise, and general nervous irritability; but the group, as a whole, consists of those which result from general sympathetic stimulation.

Regulation of Body Temperature Under Normal Conditions.—It is impossible to study fever without discussing regulation of the normal body temperature. All body activities call for increased metabolism and, with the exception of nerve discharge, are accompanied by increased heat formation.

The demands upon the body made by metabolic changes are met by the consumption and oxidation of food. When an increased amount of heat is produced, whether by consumption and oxidation of food, or by the increased functional activity of some organ or organs, or by muscular exercise, unless the channels through which heat is eliminated from the body are stimulated to a similar degree, heat will be stored up in the body and there will be an increase of body temperature. The principal channel through which heat is eliminated is the skin; from which it is thrown off by radiation, convection and evaporation of sweat, the degree of dissipation depending upon the vasomotor control of the blood vessels which course in the skin. Some is also thrown off in the expired air, the urine, and feces. The following quotation from Starling's Physiology[2] shows the relative percentage of heat given off through the different channels of elimination.

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[1] Pottenger: The Syndrome of Toxemia, Journal American Medical Association, January 8, 1916, vol. lxvi.

> "The main regulation of heat loss thus takes place by the control of the nervous system over the cutaneous circulation and the sweat-glands. Besides these channels of heat loss, others may play an important part under certain conditions. Heat is lost to the body in warming the food and air which are taken in. It is also lost in respiration in the evaporation of water and the setting free of CO_2 from watery solution into the expired air. The following estimate by Tigerstedt represents the proportion of losses in an adult man by these different ways:

A. WARMING THE FOOD AND AIR.

		Cal.
(1)	1500 g. water drunk at 15° C. and warmed to 37.5°—raised therefore 22.5°	33.75
(2)	1500 g. food eaten at 25° C. (mean) and warmed to 37.5° raised therefore 12.5°; specific heat 0.8	15.00
(3)	15000 g. (— 11,500 1.) air respired at 15° C. and warmed to 37.5°—raised therefore 22.5°; specific heat 0.237	79.95
		128.70

B. LOSS OF WATER AND CO_2 IN THE BREATH.

		Cal.
(4)	It is assumed that the inspired air is half saturated with watery vapor at 15° C. and that the expired air is fully saturated at 37.5° C. Approximately 450 g. of water would be given off therefore in the form of vapor from the respiratory passages; the latent heat of the water vapor is 0.537 Cal.	241.70
(5)	The absorption of heat in the liberation of CO_2 from the lungs (800 g.); 0.134 Cal. per g.	107.20
		348.90
	From above	128.70
	Total	477.60

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[2] Human Physiology, 2nd ed., Lea and Febiger, Philadelphia, 1915.

"The sum of heat losses specified under these five headings amounts to 477.60 calories. Estimating the total heat loss of an adult man at 2400 calories this sum represents only about 20 per cent of the total. The remaining 80 per cent (in round numbers) takes place through the skin.

"If we estimate the total heat loss of an adult man at 2400 calories, we may say that about 5 per cent of the total heat loss takes place by warming the food and air, about 15 per cent by the evaporation of water and CO_2 in respiration, and about 80 per cent by radiation and convection and the evaporation of sweat from the skin. The proportion represented by the last factor will increase very largely in the presence of a high external temperature, or of an excessive heat production in consequence of violent muscular exercise."

The normal body temperature is preserved by maintaining an equilibrium between the forces which govern heat production and heat dissipation. If, under normal conditions, increased heat is produced in the body, the channels for its elimination are automatically stimulated and more heat is thrown off. If, on the other hand, there is a decreased production of heat within the body, the channels of elimination are closed and, in this way, the body is protected from continued dissipation of heat. At the same time, if checking elimination is not sufficient, the muscles may be called upon to produce heat by shivering or rigor. Heat production depends upon chemical activity; heat loss on physical regulation.[3]

J. L. Jona[4] has given a very interesting discussion of heat production and heat loss during experimental fever. He found that the first effect to be noted during a rise of temperature following the parenteral injection of foreign protein was that of *marked constriction of the ear vessels, and marked diminution in the respiratory rate,* which reached their minimum before the rectal temperature reached its maximum and then, after a short time, the vessels began to dilate and the respiratory rate increased. When the temperature rose above its initial value this dilatation of the ear vessels was soon followed by a fall in rectal temperature to normal. As the rectal temperature began to fall to its initial level, the ear temperature also began to fall to its initial level. This would indicate that the rise in temperature was due in these cases to a disturbance on the part of heat elimination, as well as to an increase in heat production; because, under normal circumstances increased elimination would have quickly restored the temperature equilibrium as it does after the rise which occurs following severe physical exercise, such as a game of tennis. (See page 115.)

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[3] Krehl: Clinical Pathology, translated by Hewlett, J. B. Lippincott & Co., Phila., 1903.

[4] A Contribution to the Experimental Study of Fever, Journal of Hygiene, 1916, vol. xv, No. 2.

He also considered the CO_2 output. From this he draws the conclusion that the variation in temperature must be attributed to variations in heat loss, inasmuch as there is no regular increase in oxidation. He likewise further believes that the action of the fever producing substance is upon the central heat regulating organism which is supposed to be situated in the neighborhood of the corpus striatum.

Cause of Fever.—Fevers in which we are most interested in our study of tuberculosis, are those which are due to toxic action, although there are many other rises in the temperature curve which are caused by factors only indirectly due to the tuberculous process. During fever it is said that with each degree of increase in temperature there is an increase of about 10 per cent in the total amount of body heat. Thus, one can see what enormous quantities of heat are contained within the body during a high temperature. Heat production, as a rule, is highest at the beginning of acute infections. This fact gives a clue to the rational cause of fever.

Vaughan[5] gives the following summary of important contributions to the study of fever:

> "In 1888, Gamaleia[6] showed quite clearly that fever accompanies and results from the parenteral digestion of bacterial proteins, and a year later Charrin and Ruffer[7] confirmed this work and extended it to non-bacterial proteins. In 1890 Buchner[8] produced the characteristic phenomena of inflammation—calor, rubor, tumor and dolor—by subcutaneous injections of diverse bacterial proteins. In 1895 Krehl and Matthes[9] induced fever by the parenteral introduction of albumoses and peptones, but they did not obtain constant results, which we now know are secured only by regulation of the size and frequency of the dosage. In 1909, Vaughan, Wheeler, and Gidley[10] demonstrated that any desired form of fever (acute, fatal,

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[5] Protein Split Products in Relation to Immunity and Disease, Lea and Febiger, Philadelphia, 1913.

[6] Annuals de l'Institut Pasteur, vol. xii, p. 229.

[7] Comptus rendus des séances et memoires de la Société de biologie, Paris, 1889, p. 63.

[8] Berliner klinische Wochenschrift, 1890, s. 216.

[9] Archiv. für experimentelle Pathologie und Pharmakologie, 1895, Leipsie, Bd. xxxv, s. 232.

[10] Journal Američan Medical Association, August 21, 1909.

> continued, intermittent, or remittent) can be induced in animals by regulating the size and frequency of the doses of foreign protein administered parenterally, and in 1911, Vaughan, Cumming, and Wright extended the details of this work.''

In addition to the works just cited, I would like to call attention to the work of Panum and Weber and Billroth as cited by Jona:[11]

> ''Panum (1855) extracted from putrefying solutions a heat-stable body, insoluble in alcohol, but soluble in water, of which 0·012 grain would kill a small dog, producing febrile disturbance and symptoms of acute infection.
>
> ''In 1864 Otto Weber and in 1866 Billroth introduced septic material into circulating blood or cellular tissue and they were the first to compare the artificial fever thus induced with ordinary 'surgical' fever. They found that the inoculation of putrefactive material, whether of animal or vegetable origin, led to the production of a febrile state reaching its maximum in two to twenty-eight hours. It was also shown that the products of acute inflammation produced fever under similar conditions and that these products owed their infective properties to the presence of 'microphytes.' It was concluded that the fever was therefore due to these bodies.''

The work of Vaughan and his pupils, however, has given us most important data by demonstrating that the various types of fever met with clinically may be produced in animals by regulating the size and frequency of the doses of foreign protein administered parenterally. This must be accepted as one of the most valuable contributions that has been made to the subject.

In the production of experimental fever it will be seen that conditions are met with similar to those found clinically; that is, that different animals react differently to the introduction of foreign protein. One will react more markedly than another, and in one case the temperature curve will differ greatly from what it does in another. It is a common experience, clinically, that different individuals differ in the types of temperature curve, although comparable characteristics may usually be discovered for each particular type of infectious agent.

It is impossible to discuss the question of fever, which might be termed ''pathological rise of temperature'' to distinguish it from physiological rises, without discussing the normal heat regulation of the body. The preservation of the normal temperature in warm blooded animals is accomplished by a heat regulating mechanism described in preceding paragraphs, which maintains a fairly definite equilibrium, no matter what the degree of the temperature of the medium surrounding the animal and regardless of the increase or decrease of heat production within the body. Eating a large meal may be followed by an increased oxidation of food and a marked increase in heat production; yet the avenues of elimination will be so regulated that there will be little or no change in the temperature of the body, as determined by thermometric readings; and such change as does occur is only temporary in character. By muscular exercise a sufficient amount of heat may be produced at times to raise the body temperature several degrees; thus, a game of tennis may be followed by a temperature of 102°, but the heat regulating mechanism increases the elimination of heat and the normal of 98.6° is soon restored.

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[11] A Contribution to the Experimental Study of Fever, Journal of Hygiene, 1916, vol. xv, No. 2.

An individual may be exposed to air of very low temperature and yet his body temperature remain stable. On the other hand, he may be surrounded by very hot air, and still be able to maintain or quickly restore his heat equilibrium. It is important to note that the increase of temperature produced by such physiological acts, as an increased amount of food consumed, and muscular exercise, likewise changes in temperature of the external environment, are not accompanied by the usual symptoms which accompany pathological fever. This indicates that physiological hyperpyrexia and pathological hyperpyrexia are entirely different processes.

It is important to note that pathological hyperpyrexia of this type does not disappear within a short time, like the physiological hyperpyrexia due to violent muscular exercise, such as in the game of tennis.

Heat elimination from the body is controlled by the sympathetic nervous system because so large a percentage of heat is given off through the skin. The vasomotor nerves are branches of the sympathetic nervous system; consequently, in the study of fever it is necessary for us to direct our attention to the sympathetic system, and determine, if we can, any changes on its part which interfere with heat elimination. This we find in the vasoconstriction mentioned above. This is especially interesting because it suggests that fever has the same cause as other symptoms of toxemia. With this conception, *fever becomes an integral part of the syndrome of toxemia, and is explained as being a part of the general discharge through the sympathetic nervous system.* The importance of the vasomotor control of heat elimination may be seen in the quotation from Starling mentioned above.

This conception of fever comports with the facts which are constantly observed experimentally, as well as conditions which may be inferred to exist during infections. *That an increased heat production sufficient to raise the body temperature several degrees, such as is now and then noted, following the parenteral injection of extremely small doses of foreign protein, can be directly due to the increase in heat produced by the chemical changes which take place during the destruction of this protein, does not seem reasonable.* Thus, I have seen a rise of temperature to 103° following an injection of 2 mgms. of Koch's Old Tuberculin. These injections of small quantities of protein, however, have a definite action upon the central nervous system, and produce a definite syndrome, of which fever is one factor. While this syndrome is partially that of general nerve disturbance, yet it manifests itself most markedly throughout the sympathetic nervous system. In this way we account for the lack of appetite; dry mouth; disturbance on the part of the gastrointestinal tract, which takes both the form of deficient secretion and deficient motility; also disturbance on the part of the heart, manifested in the increased pulse rate; and disturbance in the cranial circulation, manifested by headache.

From this it is but natural to further assume that stimulation of the sympathetics might show itself in the production of the vasoconstriction causing heat retention and a resultant increase of body temperature. That this does occur is shown by the vasoconstrictor influence, as noted in the ear of the rabbit, following the parenteral injection of foreign protein, as previously mentioned (Jona). It is also noted clinically as a tendency to chill or a rigor in patients at the beginning of acute infectious diseases and during the rise of temperature in chronic fevers.

That fever is a result of both the interference with heat dissipation and an increased heat production may be inferred from a number of observations which are made on patients suffering from tuberculosis, particularly during the fever stage. It is such a common observation that patients' temperatures are influenced by little things, that it is common to mention that the heat regulating center in tuberculosis is unstable. In this way we explain the oft noted effect of the various emotional states, such as joy, sorrow, disappointment, worry, anxiety, and fear. These emotional states exert their influence through the sympathetic nervous system, and thus, through the vasomotors influence heat dissipation. By producing vasoconstrictor effect, they decrease heat elimination and thus cause a rise in temperature. These will be discussed later.

It has recently been suggested by Crile[12] that the production of fever is a part of the general *kinetic drive*, that it represents a defensive force the same as muscular action. He conceives of man as being a machine which has gradually developed a protective mechanism. The power to strike is developed because man has been assailed by enemies in the past. The production of fever has resulted from the fact that man is assailed by bacteria. Entering the body they produce certain action upon the body cells, which cause a defensive reaction, resulting in the rise of temperature and other symptoms which result from stimulation of the bacteria.

Crile's theory is extremely interesting and gives us a very important angle from which to study body defense.

Effects of Fever.—We must be careful, however, not to make too much of fever. Fever is one of the many symptoms which is produced as a result of the entrance of bacterial protein into the body and its production results probably from two factors; the first, the usually recognized factor of increased production of heat due to increased chemical action; and the second, the usually neglected factor of stimulation of the vasomotor system through the sympathetic nerves, causing vasoconstriction and a lessened heat loss; consequently, we must look upon it as a part of the syndrome of toxemia and not an entity producing the syndrome of toxemia. Continued fever might be followed by pathological change; but more careful study will undoubtedly show that pathological changes which have heretofore been attributed to fever, are, in all probability due to the same cause as those which produce fever. Continuous irritation of nerve cells must result in disturbed function and later in trophic changes in the body cells supplied by the filaments arising from the injured cells.

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[12] The Origin and Nature of Emotions, W. B. Saunders Company, Philadelphia, 1915.

While fever must be looked upon as a part of the general syndrome of toxemia; at the same time, it is probable that certain definite changes in the body might be produced by the long continuance of the hyperpyrexial state. There are certain variations in cell texture as well as cell function which occur during the course of high prolonged fever. These are often attributed to the fever. They may, however, be due to changes wrought through the nervous system, as a result of the same stimulation as that which produces the hyperpyrexia.

In an infection like tuberculosis, the effect of raising the body temperature several degrees must be considered in its relationship to bacterial growth. Tubercle bacilli thrive best at body temperature. The temperature of 101° and 102°, which is commonly found in chronic active tuberculosis, if attained by the artificial media on which tubercle bacilli are growing, would result in an inhibition or cessation of growth. The same thing probably occurs in the human body. It seems to be definitely proved that there is an increase in antibody production during fever periods. It is necessary in studying this question to bear in mind, however, that hyperpyrexia is not the only condition present when an increase of antibodies is found. Caution must be used in ascribing it wholly to the presence of fever.

The general conclusions of Vaughan in his discussion of protein fever are so important in bearing upon this subject that I wish to quote them extensively:

"*General Conclusions.*—Protein fever, and this includes the great majority of clinical fevers, results from the parenteral digestion of proteins.

Bouillaud[13] was practically right when he said: 'La fièvre est une maladie, dont la nature est toujours la même.' Proteins, living and dead, occasionally find their way into the body. They may come from without or from within. Crushed bone, muscle, or other tissue, on being deprived of its vitality, or detached from its normal surroundings, becomes foreign material and must be broken up preparatory to its elimination. Under certain conditions, proteins taken into the alimentary canal escape enteral digestion and are in part absorbed unbroken. When this happens they are disposed of by parenteral digestion. In a finely divided form, as in the pollen of plants, proteins are absorbed from the respiratory tract and give rise to the condition designated as hay or rose fever. But, in the great majority of instances proteins gain entrance to the body in unbroken form, as living proteins, bacteria, or protozoa. The parenteral proteolytic ferments are of two kinds, non-specific and specific. The former are normally present in the blood and tissues, especially in the former, of all animals. They differ in kind in different species and in amount and efficiency in individuals. Their purpose is to break up foreign proteins that find their way into the blood and tissues. They are, within limits, general proteolytic ferments, as are those of the alimentary canal; though the variety of proteins upon which they can act is more limited. They constitute the most important factor in racial and individual immunity. Man is immune to most bacteria, not because they do not elaborate poisons, for every protein molecule contains its poisonous group, but because they are destroyed by the general proteolytic enzymes as soon as they enter the tissue and consequently are not permitted to multiply in man's body. These non-specific, parenteral proteolytic enzymes are probably secretions of certain specialized cells. Under natural conditions these enzymes are capable of digesting those proteins upon which they do act only in small amounts, but the cells which elaborate them may be stimulated to increased activity by proper treatment, and the method detailed in this paper seems to accomplish this purpose. Whether or not these enzymes become qualitatively specific under such treatment as we have detailed can be determined only by further study. The immunity secured by these enzymes is limited in extent and transitory in duration.

''The specific, parenteral proteolytic ferments are not normal products of the body cells, but are brought into existence under the stimulation of those proteins introduced into the blood and tissues, which on account of their nature or amount escape the action of the non-specific ferments. It is to the development of these ferments that the phenomena of sensitization (wrongly called anaphylaxis) are due. A protein introduced into the blood and not promptly and fully digested by the non-specific enzymes is discharged from the blood current and deposited in some tissue, the cells of which after a time develop a specific ferment which splits up this protein and is not capable of acting upon any other. For certain proteins there are certain predilection organs and tissues in which they are stored, either exclusively or most abundantly; the pneumococcus in the lungs; the typhoid bacillus in the mesenteric and other glands; the viruses of the exanthematous diseases in the skin, etc. For the development of the specific proteolytic ferments time is required, and this varies with the protein and probably with the tissue in which it is deposited. The development of these ferments necessitates changes in the chemical constitution of the protein molecule of the cell, and by this means the cell acquires a new function, which subsequently is brought into operation only by contact with that protein to which its existence is due. As a result of this rearrangement in molecule structure, the cell stores up a specific zymogen which is activated by contact with its specific protein. This explanation of the phenomena of sensitization originated in this laboratory,[14] and was not simply a fortunate guess, as has been assumed by some. The same is true of the statement made at the same time, that protein sensitization and bactericidal immunity are identical, and not antipodal, as they may appear to the superficial observer. A close study of the split products of bacterial, vegetable, and animal proteins, and especially of the poisonous group found in all proteins, had already been made in this laboratory. A study of the symptoms induced by the protein poison and of those following a second administration to the sensitized animal was certainly good and sufficient ground for concluding, as then stated, that the man that dies from the administration of morphine and the one that dies from opium both owe their death to the same poison. The most valuable experiments of Friedberger and his assistants, and of Pfeiffer and Mita, have, in our opinion, fairly established the validity of this explanation. In 1910, Friedberger[15] made very plain the relation between sensitization and the infectious diseases, and in his address at the meeting of the German naturalists at Königsberg in September, 1910,[16] he dwelt most instructively upon the wide application of the facts learned in his studies of sensitization.

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[13] Traité clinique et expérimentale des Fièvres, 1826.

''Whether the products of digestion, with the non-specific ferments and those elaborated by the specific enzymes are identical or not remains to be ascertained. The presence of a poisonous group in the protein molecule is disclosed in both enteral and parenteral digestion, as well as by our process of splitting up the protein with dilute alkali in absolute alcohol. In the first case it appears in the peptone molecule, which is large and complex. By the chemical process, it is obtained as a less complex, more diffusible, and consequently more active body. Between the two there are probably several intermediate substances. The promptness in action manifested by all proteolytic ferments, is determined, in part, at least, by the proportion between the surface of the substrate and the mass. We observed some years ago[17] that the more finely divided the cellular substance of bacteria is, the smaller the dose which proves fatal. This is due to the greater surface exposure, and the same apparently holds good for colloids in solution. When soluble proteins are expelled from the blood and diffused throughout the animal body, the conditions for their rapid cleavage are most favorable, and consequently the fulminating phenomena observed after the second injection into a sensitized animal.

''When a protein deposited in mass is rapidly acted upon by the parenteral enzymes, more or less marked inflammation results. This may be demonstrated by injecting suspended, dead, bacterial cellular substances into the peritoneal cavity of a guinea pig when a diffuse peritonitis results, and we wish to suggest that the exanthems are due to the rapid digestion of proteins deposited in the skin. We admit that this is largely theoretical, but we have found, as already stated, that egg-white is in part deposited in the skin of rabbits after intravenous injection. This may be an explanation of the Arthus phenomenon.

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[14] Journal of Infectious Diseases, June, 1907.

[15] Berliner klinische Wochenschrift, 1910, Nrs. 32 and 42.

[16] Münchener medicinische Wochenschrift, 1910, Nrs. 50 and 51.

[17] Trans. Association American Physiologists, 1902.

''The fact that every protein molecule contains a poisonous group does not mean that the products of protein digestion must contain a poison, for the poison itself may be split up and rendered inert, as happens when the proteins in the alimentary canal are broken up into amino-acids. It may therefore happen that in certain forms or stages of parenteral digestion no poison is formed.

''The low temperature seen in some of our charts undoubtedly indicates the liberation of the poisonous group, and consequently the subnormal as well as the high temperature is a result of parenteral digestion, and it is in this stage that the greater danger to the life of the animal lies, as is plainly shown in our results. However, there is danger to life in the high temperature in and of itself. A rabbit is not likely to survive a temperature of 107°, and this was reached in at least one of our experiments, and closely approached in many others.

''Fever must be regarded as a conservative process, although like many of nature's processes it often leads to disaster. But its purpose is the disposal of foreign and dangerous material, and therefore must be regarded as beneficent.

''In parenteral digestion the following sources of heat production must be evident: (1) The unaccustomed stimulation and consequent increased activity of the cells which supply the enzymes must be the source of no inconsiderable increase in heat production. (2) The cleavage of the foreign protein means the liberation of heat. (3) The reaction between the products of the digestion and the tissues, especially when an active and irritant poison is liberated, must lead to increased heat production. We regard the first and last of these as the more important sources of the overproduction of heat in the febrile state.''

I would suggest as the cause of this subnormal temperature mentioned above which results in ''greater danger to the life of the animal,'' the following: Through parenteral digestion the poisonous group is liberated in such large quantities that the vasomotor mechanism is overstimulated to a degree that approaches or attains a condition of paralysis. From this, vasodilatation, with or without perspiration, ensues, which causes rapid heat loss, resulting in subnormal temperature. A condition of collapse follows which results in death unless the vasomotor equilibrium is soon restored.

Whether fever shall be looked upon as a conservative process or not depends upon our point of view. It is probable that it has an inhibiting action upon the growth of bacteria. It is also possible that the formation of specific proteolytic ferments may take place more actively when the body temperature is elevated. Many observers have reported optimistically on this point, while it has been denied by others. Looking at it broadly, can we assume that it is any more conservative than the malaise and general nerve instability, the rapid heart action, the disturbance in digestion and the headache which, along with fever, make up the syndrome of toxemia? We must not lose sight of the fact that it is only one part of a general sympathetic stimulation; and sympathetic stimulation, when long continued, lessens nerve force, and reduces the digestive and assimilative powers.

While the three causes above mentioned may be the principal sources of heat production, I would suggest that *they are probably still insufficient with normal response on the part of the heat eliminating mechanism to account for the elevations in temperature met with in experimental protein poisoning or in the acute infectious diseases.* When, however, there is added to the increased heat production a stimulation of the vasomotor nerves, resulting in vasoconstriction and interference with heat elimination, then the phenomenon of fever can readily be conceived of as being a part of protein digestion.

Application of the Principles in Tuberculosis.—If we are now to apply these principles of fever production to tuberculosis we can see that different factors are taken into consideration at different times in the course of the disease. During early activity the principal feature in the production of fever is probably the protein from the tubercle bacilli. Later, after increased necrosis and caseation occurs, the body is called upon to care for the various protein molecules which result from the destruction of tuberculous tissue. If other bacteria complicate the process and gain entrance to the blood and lymph streams, they must also be dealt with by the body cells (mixed infection). That mixed infection occurs at times is probably true, but that it occurs as frequently as has been generally believed, is open to question. While I was formerly a staunch believer in mixed infection being an important process in all cases of advanced tuberculosis, I am gradually becoming more of the opinion that associated bacteria are comparatively an unimportant part of the pathology of tuberculosis. While we have the proteins above mentioned as causative factors of the fever, we have peculiar conditions present which make heat elimination decidedly unstable. Absorption of protein is followed by the syndrome of toxemia which manifests itself upon and through the nervous system. Through this it influences the vasomotor control, thus disturbing the important regulative mechanism which controls heat elimination.

The fever curve of the tuberculous patient is particularly sensitive and shows variations from the normal curve upon the least provocation. I do not mean to imply that there is anything peculiar in the protein present in tuberculosis to cause this. It is probable that it would occur in any prolonged toxemia that the patient might experience; but the fact that the tuberculous patient does suffer from chronic toxemia makes this more evident. We must not be unmindful of the fact that there are other important circulatory changes caused directly by the influence of the disease within the lungs, which have a tendency to disturb the vasomotor control. As one of these I would mention the splanchnic congestion which is often present when the inspiratory act is seriously interfered with.

From our preceding discussion it is evident when we are considering pathologic rises in body temperature, as they occur in tuberculosis, that we are studying a symptom due largely to sympathetic stimulation. While there are many others of similar origin, such as general nerve instability, acceleration of the heart beat, and disturbance in the secretion and motility of the gastrointestinal tract; yet, fever is one that we can measure, consequently, fever gives us an important indication of the amount of sympathetic disturbance present, hence the degree of toxemia.

This conception of fever being principally a disturbance of heat elimination does not ignore the fact that there is also probably an increase in heat formation. Heretofore, we have laid most stress upon heat formation, but, I believe, wrongly. My belief is supported by the fact that a rise of temperature is also produced by other factors which stimulate the sympathetics and increase vasoconstriction, such as depressive emotional states and some of the internal secretions. *If the mechanism which controls heat elimination was not disturbed, we would expect the same rapid dissipation of heat during and after pathological rises of temperature as take place during and after physiological rises of temperature. The very fact that pathological pyrexia is prolonged indicates that a deficient elimination is a factor.*

A well-constructed temperature curve is of great value in the study of any toxic condition. The importance of other factors which disturb heat control, however, must always be kept in mind in attempting to explain a given temperature curve. The toxemia and depressive emotional states are the two chief factors which seriously affect the temperature curve in tuberculosis. In this connection, however, we must not lose sight of the fact that there are various internal secretions which must be considered, such as adrenin, the secretion from the thyroid and that of the ovary, the last of which I shall mention in connection with the premenstrual rise of temperature.

Accurate Temperature Measurements.—The temperature curve to be of any value, in the study of the pathologic conditions underlying, must be based on accurate measurements. An accurate thermometer is necessary, although variations of one or two-tenths will have no effect except in cases of early tuberculosis where the toxemia is slight. The value of accurate methods, however, cannot be emphasized too strongly. The thermometer must be held under the tongue for a sufficient length of time to allow it to register the highest point. It should be held in the mouth as long as the temperature continues to rise. During the time of taking the temperature the mouth should be held firmly closed, and the thermometer should not be removed from the mouth during the period of registration, otherwise an extra amount of time should be added because of so doing. If the patient has been out in the cold it will take several minutes for the mouth to become sufficiently warm to give an accurate measurement. Ten or fifteen minutes are often necessary after entering a room to restore the temperature, as measured under the tongue, to its normal equilibrium. If one is out in the cold air, particularly with a brisk wind blowing against the cheeks, such a degree of vasoconstriction of the vessels of the face occurs that the temperature registered under the tongue is no more exact than that taken in the axilla. Under such conditions the rectal temperature is to be preferred. The rectal temperature is always more reliable than that taken by the mouth or axilla, but, for evident reasons, is not applicable to ordinary routine work. Neither is it essential, if the patients are trained to take their temperatures correctly. One can secure a curve sufficiently accurate for all practical purposes by observing the rules of keeping the mouth closed and allowing the thermometer to remain in the mouth sufficiently long for complete registering, except in those cases where the mouth temperature is greatly depressed by intense cold from the surrounding medium, or by the patient being a mouth breather. The patient should also refrain from taking a drink of either hot or cold water, or eating food immediately prior to the taking of the temperature. Chewing gum will bring sufficient blood to the tissues to cause a rise of a few tenths of a degree. These principles should be carefully borne in mind in studying the temperature curve. Much needless concern is often caused by a failure to recognize the errors in temperature measurement.

Variations in Temperature Curve.—The temperature curve in tuberculosis shows two types of variation from the normal. As I have previously stated, there is a normal diurnal variation varying from one degree to a degree and a half, which seems to depend upon the body activities, the lowest point being sometime in the early morning and the highest in the afternoon. Fig. 113, page 126, shows such a normal curve. Oftentimes, the temperature curve, as a whole, is elevated, the maximum morning temperature being anywhere from 98° to 100° or 101°, and the maximum for the day being a degree or a degree and a half higher. At other times the normal diurnal variation is disturbed; the minimum temperature for the day being normal, and the maximum for the day, above normal. It may be only slightly above or markedly above. Instead of a normal variation of a degree or a degree and a half there may oftentimes be two degrees, or even eight or ten degrees in the diurnal wave. I shall endeavor to explain the cause of these variations in the discussion of the various types of temperature found in the course of the disease and illustrate these departures from the normal by clinical charts.

The Temperature Curve of Continuous Toxemia—Early Tuberculosis.—Vaughan has shown that if, in experimental animals, the dosage of protein is administered at frequent intervals and kept up over a prolonged period of time, the resultant temperature assumes the continuous type. This type of curve is found under several different conditions in tuberculosis. The temperature curve in early clinical tuberculosis, as seen in Fig. 114 is of this type, and indicates a continuous inoculation of toxins going on over a variable period of time. We conceive of it being produced by the tubercle bacilli which are implanted in the tissues going through the double process of developing and being destroyed as long as activity persists; and, as a result of both processes toxins gain access to the blood stream. These toxins are acted upon and destroyed by the ferments of the body, both specific and non-specific. The increased chemical activity attendant upon their growth and destruction produces increased heat; and either they themselves or some of the products which are elaborated in their oxidation act upon the central nerve cells, and, particularly through their action upon the sympathetic and endocrine systems, produce the syndrome recognized as being due to toxemia, a part of which is a rise in temperature. This rise is usually noted in the minimum temperature

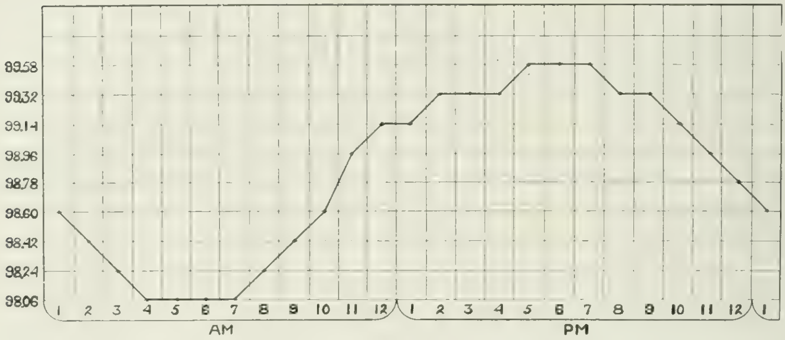

Fig. 113.—Illustrating the diurnal variation in body temperature (rectal) under normal conditions. It will be noticed that the normal temperature has a daily variation of about one to one and a half degrees. (Juergensen.)

of the morning, as well as the maximum of the afternoon. It is rare in this early clinical tuberculosis to find any particular disturbance in the diurnal variation, but the temperature, as a whole, is elevated. The early morning temperature, instead of being 97° or 97.5° may be 98°, and the maximum for the day, instead of being 98.6° may be 99.2° or 99.3°. The rise in the early morning temperature is rarely commented upon in literature, yet it is as constant and important as that of the rise in the afternoon.

In order to obtain the minimum temperature in the morning, the record should be made before the activities of the day begin. I have my patients take their early morning temperature when they first awaken, before coughing, making their toilet or exercising. By so doing, I find 97.4° or 97.6° to be common

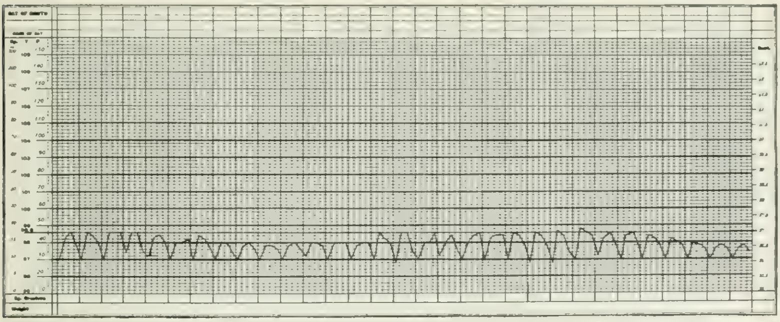

Fig. 114.—Chart illustrating early clinical tuberculosis showing intermittent inoculation of tubercle protein which produces a temperature above the regular curve for a short time, then followed by a lower level; these curves correspond to waves of increased and decreased activity. The minimum morning temperature is about normal.

when the disease is quiescent, and a slight rise above this when slightly active. If this measurement is not taken until a later hour, say eight o'clock, or until after the patient has been up and engaged in some of the activities of the day, we then find the temperature already rising, and often note a register of 98° or probably above this. Such a temperature curve would have a diurnal variation much less than the normal. Fig. 77, Volume I, page 375, illustrates the difference between taking the temperature on awaking, at half past five, and taking it at eight o'clock, in a patient with moderately advanced, slightly active disease. In some sanatoria I have noted that the first registration is at eight or nine in the morning. This always gives a high minimum for the day, and, according to my observation, takes away considerable of the value that comes from studying the temperature curve, because the diurnal variation which gives important information as to the character of the pathological process which is going on is not shown.

Acute Miliary Tuberculosis.—Acute miliary tuberculosis is accompanied by a toxemia which produces continuous temperature in which the normal variation may or may not be markedly disturbed. Sometimes the swing is increased two or two and a half degrees, particularly, if it is engrafted upon an old chronic tuberculosis, in which case the curve is not that of a pure miliary tuberculosis, but a combination of the miliary with the type of disease which previously existed. In miliary tuberculosis we often find both the minimum and maximum temperatures elevated. The minimum morning temperature is commonly from 100° to 101°, and the maximum about a degree and a half more than this, as shown in Fig. 115.

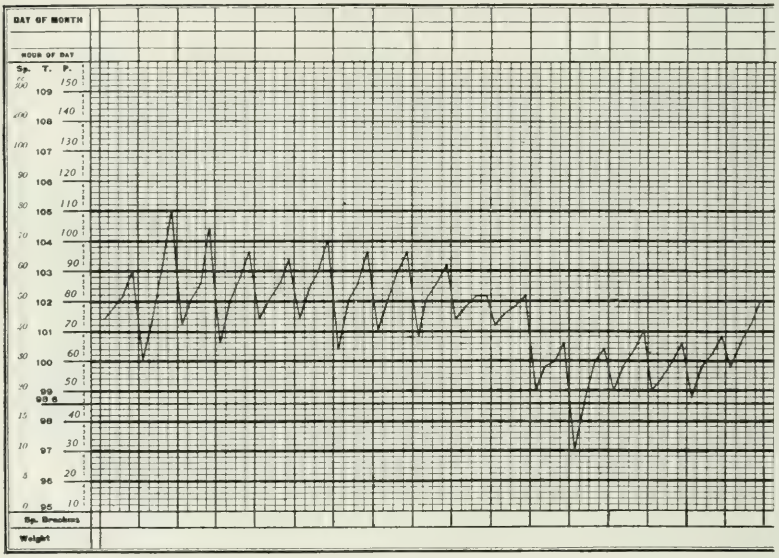

Fig. 115.—Chart of patient suffering from acute miliary tuberculosis with fatal issue in three weeks. It will be noticed that the diurnal variation is not great, although the temperature was very high as long as the patient was able to react.

The toxemia of miliary tuberculosis, when not engrafted upon a previously active process, indicates a continuous inoculation with the pure tubercle protein produced during growth, because the tubercles are so young that necrosis of tissue and death and destruction of bacilli is not yet a part of the process. The toxemia, however, is sometimes complicated by other factors. In that type of miliary tuberculosis, which represents an extension from some small focus in the body, which has not been previously producing recognizable symptoms, we meet pure tubercle protein toxemia. This is usually accompanied by limited disturbance in the normal diurnal variation.

In a patient who is already suffering from an advanced tuberculous process, however, we are apt to have not only toxemia produced by pure tubercle protein, but one in which the proteins from the destroyed tissue, resulting from the previous process, are added to that of the pure tubercle protein from the miliary foci; consequently, the diurnal variation in this type is, as a rule, increased and the character is determined largely by the preceding disease, as shown in Fig. 116, *A* and *B*.

Chronic Fibro-ulcerative Tuberculosis with Slight Activity.—Tuberculosis, even early clinical tuberculosis, is a chronic disease because it requires months for it to pass through the various changes leading to scar tissue and healing. Where the disease is more extensive the chronicity is increased and the life history of the disease, instead of being one of months, becomes one of years. During this period the patient experiences periods of quiescence, followed by periods of activity. During the periods of activity the bacilli multiply, toxins are produced, and the toxic syndrome manifests itself. This period is marked by a rise in the temperature curve. Both the minimum morning temperature, and the maximum temperature for the day may be elevated as shown in Fig. 117, or the minimum morning temperature may be normal or even subnormal, and the maximum may be above normal. The degree of change in the diurnal variation will depend considerably upon the degree of toxemia, and the state of the vasomotor system. If the degree of toxemia is not great, the vasomotor equilibrium is not markedly disturbed, and we note little change in the diurnal variation. If the

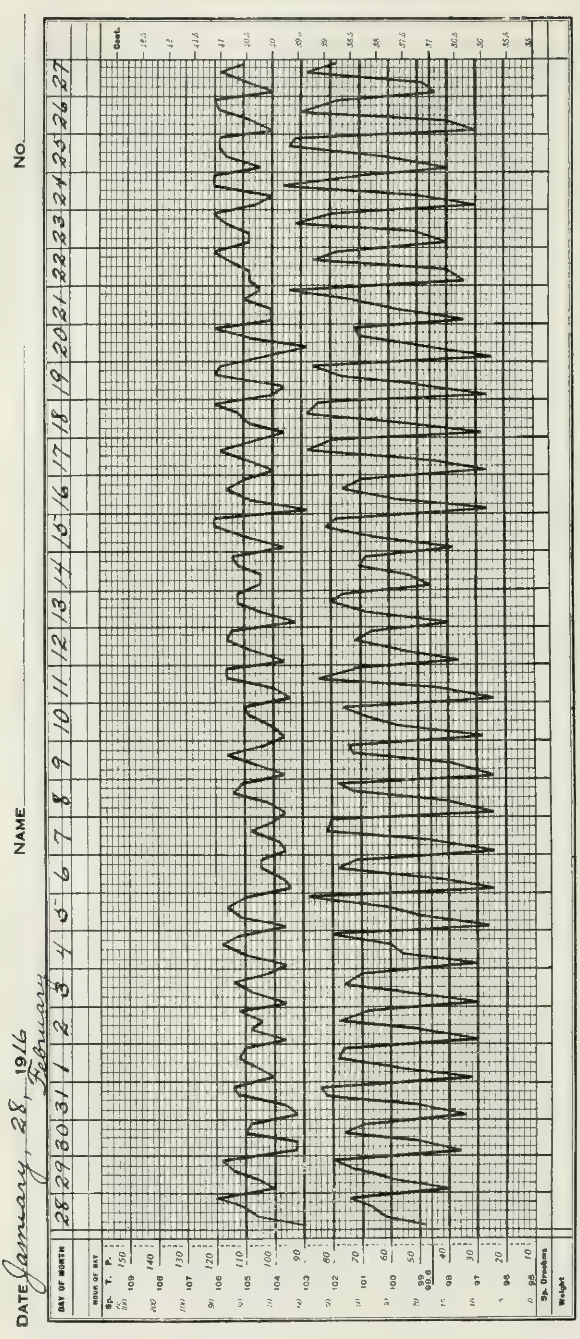

Fig. 116A.—Illustrating a generalized miliary tuberculosis involving the lung, throat, ear, and probably the intestines, engrafted upon a chronic fibroid tuberculosis. Diurnal variation increased because of character of previous pulmonary disease. Upper curve, pulse; lower curve, temperature.

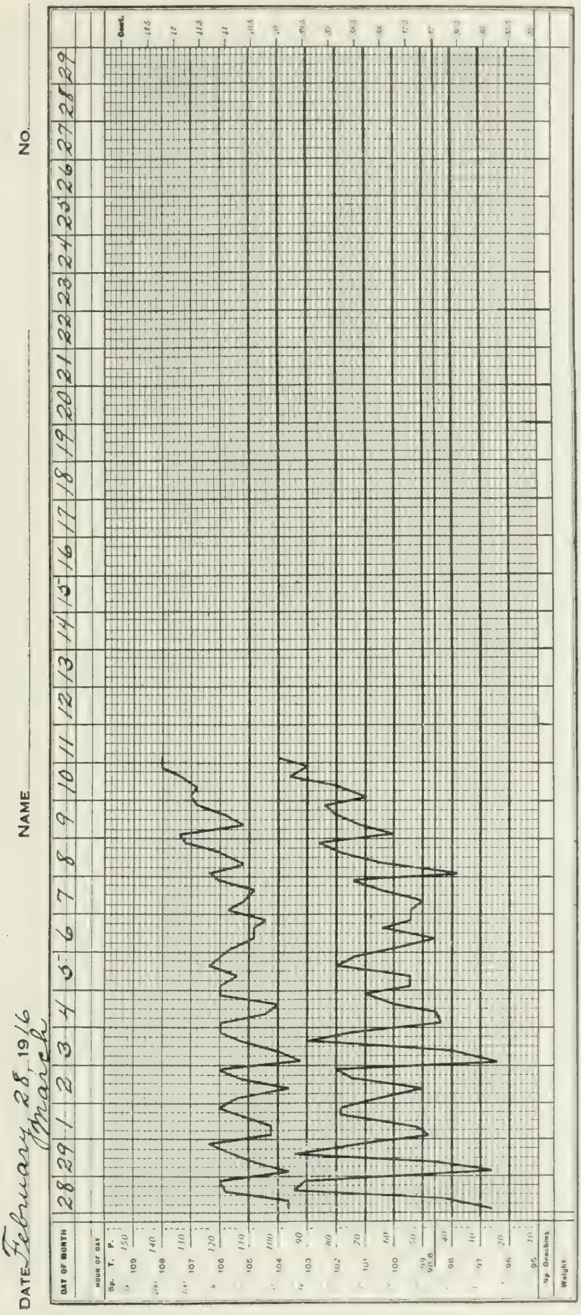

Fig. 116*B*. For description, see Fig. 116*A*, page 130. Upper curve, pulse; lower curve, temperature.

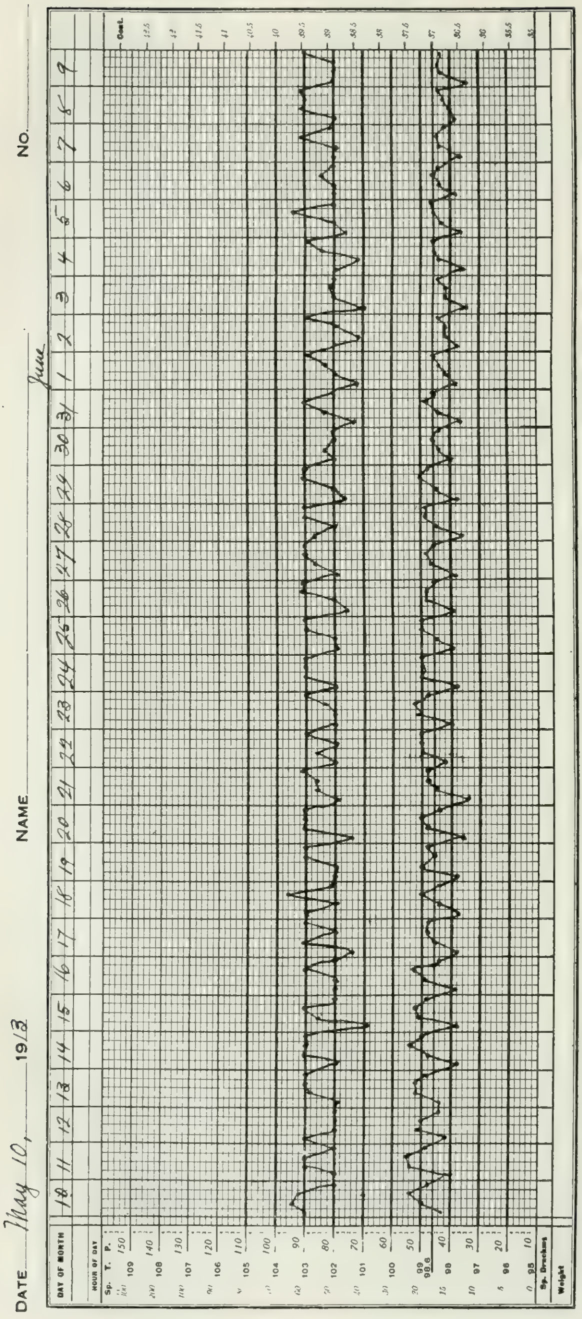

Fig. 117.—Illustrating temperature curve of chronic fibro-ulcerative tuberculosis with slight activity; showing continuous toxemia; temperature continuously above normal from May 10th to 30th. The minimum morning temperature is elevated from one-half to one degree the same as the maximum for the day. Upper curve, pulse; lower curve, temperature.

toxemia is of more severe degree, vasomotor tone is disturbed and we often note an increase in the diurnal variation, reaching a maximum of probably about two degrees. This type of temperature, as a rule, is also the continuous type because the activity in a chronic tuberculous process, as a rule, is of such a nature that when the inflammation is once started, it continues for a considerable time. Such temperature curves, however, show waves of increased, followed by waves of decreased, temperature, as shown in Fig. 118. The crests of the waves, in a very common type, are about two weeks apart. These waves mean increased inflammation in the lung, and increased toxemia, consequently are accompanied by a more pronounced sympathetic stimulation, as indicated by an increase in the severity of the symptoms.

When a temperature curve of this kind is present we can be sure that there is rather a widespread activity in the tissues, the degree of activity being indicated to a certain extent by both the maximum daily rise and the diurnal variation.

Caseous Pneumonia.—Caseous pneumonia produces a continuous temperature curve. The minimum morning temperature, as a rule, is high, ranging from 99° to 100° or 101°. The maximum temperature for the day is, as a rule, about two degrees or more above the minimum. This curve manifests a toxemia of severe degree. The patient is not always as ill as the underlying pathology would warrant; but, inasmuch as this pathological process is continuous over a prolonged period of time, the patient's condition gradually becomes worse until exhaustion finally results. This type of temperature is not wholly a temperature curve due to the tubercle proteins; but the toxemia is most probably due, in a considerable part, to the absorption of the broken down lung tissue. This is the curve of a marked degree of autolysis, as described by the writer in previous papers.[18] This type is shown in Fig. 119, page 135.

The Curve of Intermittent Toxemia.—While the two preceding types of temperature are extremely common in chronic tuberculosis there is another type of toxemia not uncommonly met

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[18] A Study of Fever in Tuberculosis with Reference to its Causation and Treatment, Journal American Medical Association, Sept. 23, 1911, vol. lvii; also Tuberculin in Diagnosis and Treatment, C. V. Mosby Company, St. Louis, 1913.

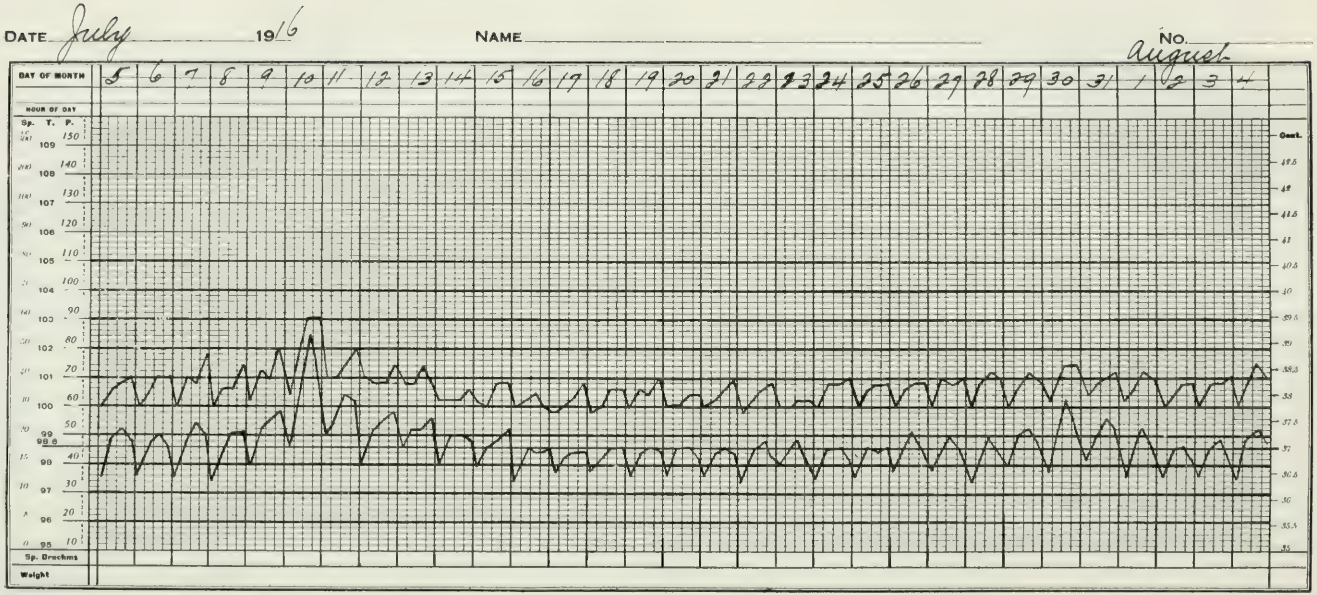

Fig. 118.—Illustrating the temperature curve of chronic fibro-ulcerative tuberculosis with slight activity, showing waves of toxemia continuous for a number of days, followed by freedom from same; diurnal variation only slightly disturbed, but the minimum for the day is above normal the same as the maximum. The two waves of increased activity, July 7 to 16, and July 29 to August 2, were due to caseation and were accompanied by increased cough and expectoration. Compare with curve due to disturbance on part of gastrointestinal tract, Fig. 124, page 147, and it will be seen that they are practically identical. Upper curve, pulse; lower curve, temperature.

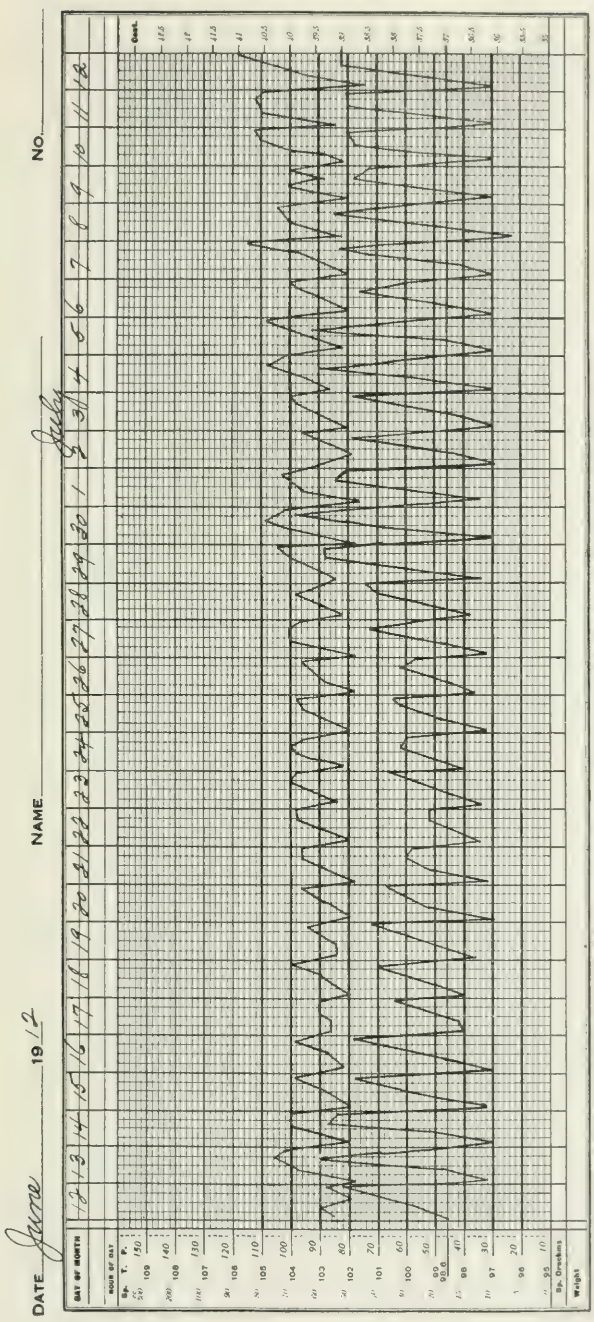

Fig. 119.—Illustrating the curve of caseous pneumonia; continuous toxemia, with diurnal variation increased. Upper curve, pulse; lower curve, temperature.

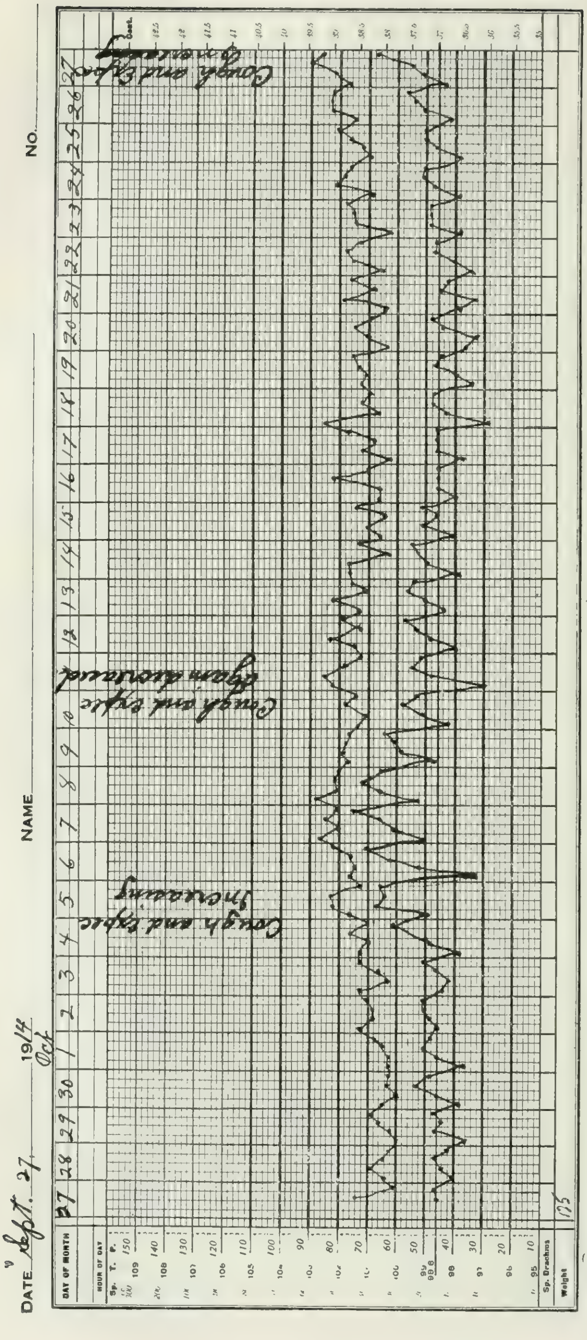

Fig. 120*A*.—Illustrating the type of intermittent toxemia as shown in chronic fibro-ulcerative tuberculosis with necrosis and expulsion of caseous mass. Upper curve, pulse; lower curve, temperature.

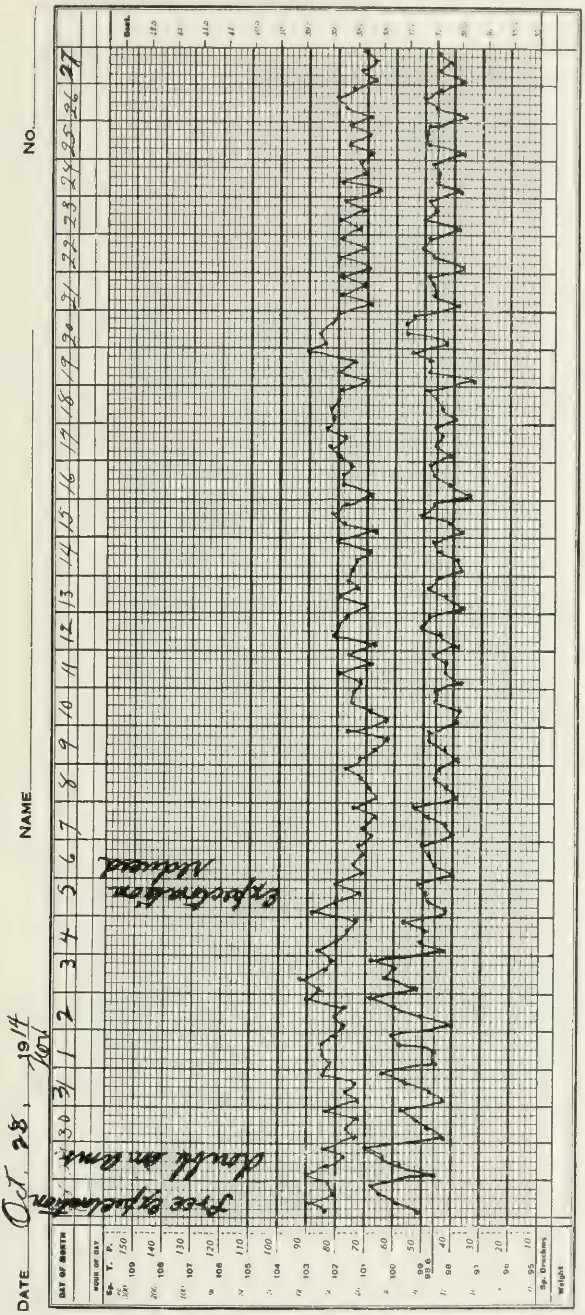

Fig. 120*B*.—For description, see Fig. 120*A*.

which produces an intermittent fever curve. The pathological process going on within the lung during this type of temperature also goes through periods of exacerbation and remission. Acute activity develops, reaching its maximum about every two weeks, followed by a remission during which time the temperature may return entirely to the normal. This type is somewhat different from the waves mentioned before in that the patient has some days of freedom from toxemia between the attacks. This type of periodic toxemia, which comes and goes with remarkable regularity, seems to be due to increased activity in some tuberculous mass which goes on quickly to rupture and expulsion of its contents. It is accompanied by increased cough and increased expectoration, and the usual symptoms of toxemia. The fact that there is a period of remission and freedom from temperature between attacks makes this type of the disease more favorable from the prognostic standpoint than those cases in which the toxemia is continuous. The relief from toxemia of only a few days' duration between attacks allows the patient to regain strength and prepares him for the next exacerbation. Such types of toxemia may be present for months and months and still be followed by a favorable result. Fig. 120, *A* and *B*, pages 136 and 137, illustrates this type of temperature.

The Curve of Severe Toxemia With Prostration.—This is the type of temperature which follows prolonged and severe toxemia and comes as an end result. It is a type where autolysis is a large factor, the breaking down of tissue is rapid, and the patient suffers not only from his tubercle toxins, but from the absorption of other toxic material from the necrotic lung. Such temperatures show a very low minimum in the morning and a very high maximum for the day. A swing of six or eight degrees is not uncommon, and ten degrees has come under my observation. This type of temperature is indicative of great vasomotor disturbance. The toxins have severely affected the nervous system and the reaction of the patient is greatly interfered with. In this type of temperature, as long as the body is able to react, we must assume that there is a markedly increased chemical action with resultant increase in heat production, as well as interference with elimination. The sympathetic and endocrine systems are unduly stimulated and the vasomotor tone is greatly disturbed. The whole picture, from the high temperature in the afternoon to the vasodilatation, perspiration, markedly subnormal temperature, and condition approaching collapse of the early morning can be accounted for by excessive toxemia followed by exhaustion of the sympathetic and endocrine systems, with a partial ability to regain equilibrium still maintained. This type is shown in Fig. 121, page 140.

This condition is in part like the collapse which comes in acute toxemia in the acute infectious diseases, likewise that which follows the introduction of large doses of protein into experimental animals. The difference is that the temperature comes after a prolonged period of toxemia, during which time the absorbed toxins have been gradually producing their effect upon the nervous and endocrine systems and affecting their stability; consequently, the result is not as marked nor as constant as that which is noted when one large dose of toxin is injected into an experimental animal, or as that noted in the acute toxemia, followed by collapse, which is sometimes met in the acute infectious diseases. The toxemia comes so gradually that there is an attempt on the part of the heat regulating mechanism to continue its function; but, owing to the increased amount of heat liberated, and the excessive disturbance in vasomotor tone, great instability is shown. The high temperature in the afternoon is followed by vasodilatation, which is not able to be controlled when a sufficient amount of heat has been eliminated to bring the temperature to the normal; consequently, the temperature continues to drop until a very low point has been reached. Oftentimes when the vasomotors begin to regain their tone a vasoconstriction ensues, a feeling of chilliness is experienced, often followed by a definite rigor. This increases the amount of temperature produced, and when added to that which results from the extra toxemia present causes a marked rise in the daily maximum.

The Curve of Inactive Tuberculosis.—In order to understand the temperature curve, which should be considered not as a temperature curve, but as an index of toxemia, one must know that clinical tuberculosis and pathological tuberculosis are different. The symptoms of tuberculosis, which make up the clini-

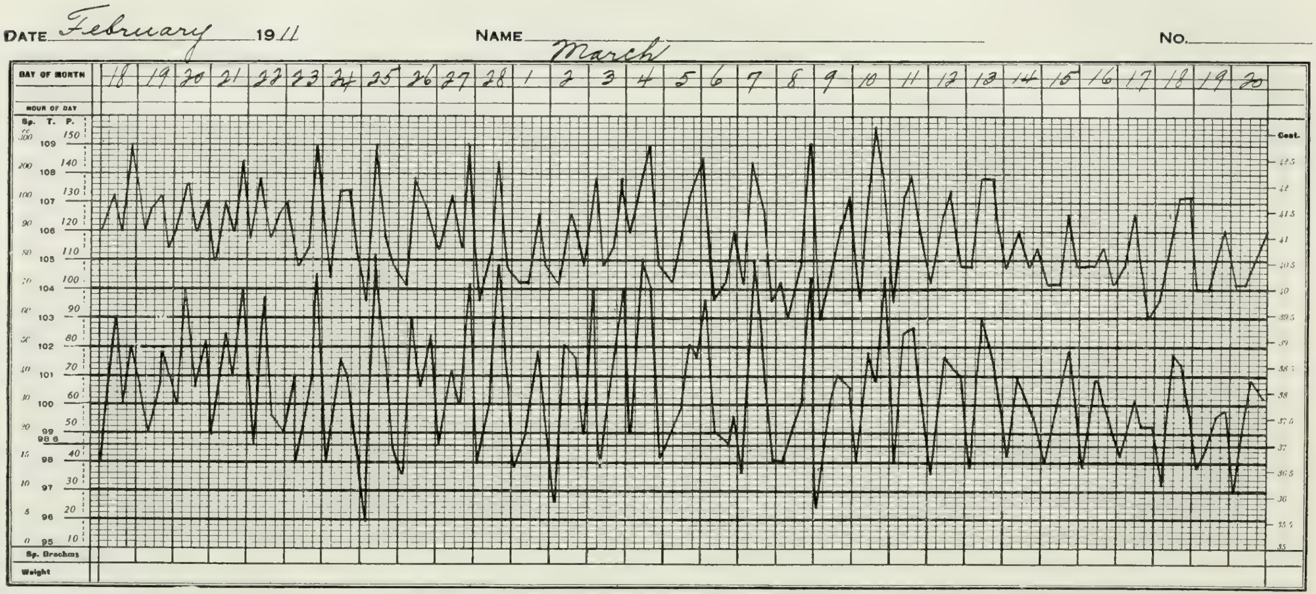

Fig. 121.—Illustrating severe toxemia with prostration; vasomotor system very unstable in patient, who is exhausted from chronic disease. Curve of severe autolysis. This patient's disease later quieted down. She lived eighteen months, a considerable portion of which time was almost free from temperature. Upper curve, pulse; lower curve, temperature.

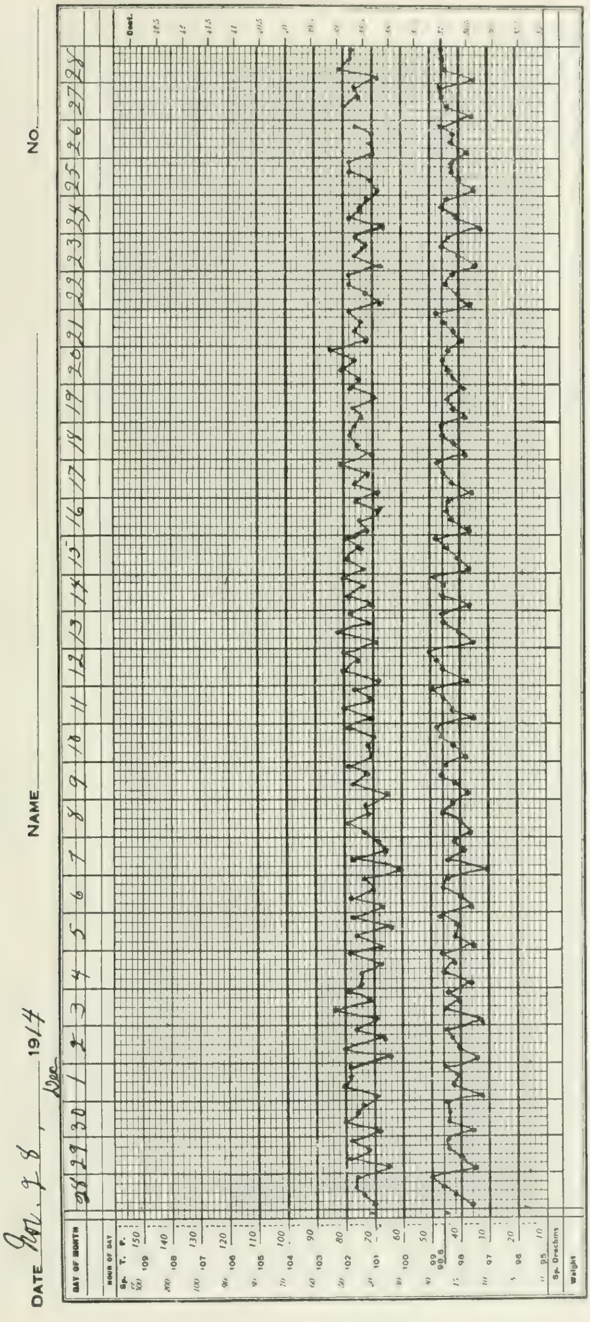

Fig. 122.—Illustrating clinically inactive chronic tuberculosis; toxemia absent or at least not producing symptoms. This chart follows immediately after charts *A* and *B*, Fig. 120, and shows in connection with them that the normal temperature does not necessarily indicate the pathological condition of the patient. Upper curve, pulse; lower curve, temperature.

cal picture, disappear long before the disease is pathologically healed. The healing of tuberculosis, if we may use that term, or, what is probably better, the arrestment of tuberculosis, and the conversion of the infiltration into scar is a slow process, requiring, in early tuberculosis, many months, probably one or two years; and, in advanced tuberculosis, considerably longer. When toxemia has ceased, however, and the disease is no longer producing clinical manifestations, we can speak of it as clinically inactive. The curve of such inactive tuberculosis is the one which I wish to discuss at this time. This is shown in Fig. 122.

If the temperature curve depended upon the severity of the preceding clinical disease there would be great variation, according to whether the disease had been a slight or severe one,—which is not the case. The temperature depends, for the most part, upon toxemia, and when toxemia has disappeared, the process which interferes with the equilibrium between heat production and heat elimination is removed, and the temperature curve should assume the normal, providing the disturbance in the temperature has been wholly due to the tuberculous process. Naturally, where other processes which produce toxemia, or other conditions which, acting through the sympathetic nervous system (vasomotors), interfere with heat elimination, enter, these must be relieved in order to have a normal temperature curve.

The point which I desire to emphasize is that clinical activity in a tuberculous process produces toxemia. This toxemia may be either constant or intermittent, and the temperature curve assumes corresponding characteristics. When all toxemia, however, has passed, the temperature curve returns to normal, providing the toxemia is the only factor in interfering with heat equilibrium. Figs. 114 and 117 (pages 127 and 132) illustrate this character of curve. It will be seen that there is very little variation in the curve following early tuberculosis and that following inactive advanced tuberculosis. The two can hardly be differentiated.

Factors Aside From Tuberculous Toxemia Which Interfere With Heat Equilibrium.—One must never lose sight of the fact that the tuberculous patient is a human being, and is subject to all other disturbing conditions and complications that might enter into the life of any other individual. These effects are likely to be more pronounced, however, because the patient is suffering from a chronic toxemia. What might not disturb the temperature curve of the normal individual may disturb that of the tuberculous individual. The vasomotor system which presides largely over heat elimination, is rendered so unstable by chronic toxemia that it is probably more easily affected by outside influences. If this point is understood much of the worry about temperature curves may be removed. Every physician who treats chronic tuberculosis is called upon to explain rises of temperature. Many of them he cannot explain to his own satisfaction, or the satisfaction of the patient. There are so many things which come in to interfere with the heat equilibrium that one is often put to his wit's end to furnish an adequate explanation, even although the patient is under what seems to be perfect control. The writer has had an excellent opportunity to study these various influences in patients who are at rest and under ideal conditions. For several years he has employed rest as a therapeutic measure for the first few months in all patients who enter the sanatorium. This has afforded an opportunity for studying these outside influences on patients in sufficient numbers, in all stages of the disease, to definitely establish the fact that many of the temperatures which are noted in these cases are not due to the tuberculous toxemia, but to influences wholly outside of tuberculosis. I will describe just a few of such influences. Others will doubtless occur to those who give the matter thought. When a rise of temperature is observed, the etiology of which is in doubt, the clinician should endeavor to determine whether or not other symptoms of toxemia are present.

The Effect of Air Temperature Upon Body Temperature.—The body temperature is affected considerably by the temperature of the air. This effect is not wholly dependent upon the temperature of the air, but on other conditions, such as humidity and wind movement. This influence is not peculiar to tuberculosis, but it may be more marked in the one suffering from this disease than in the healthy individual because of the fact that his heat control is not stable. We observe great variations in different patients in this particular. Some atmospheric conditions will cause no variation in some temperature curves, while in others, they will cause changes varying from one-half to one degree. The effect of atmospheric temperature upon body temperature is shown in Fig. 123.

In Southern California we have observed and studied these atmospheric influences upon our patients for a number of years. If the weather conditions remain constant the patients show a certain temperature curve. Other influences being eliminated, this curve represents the degree of toxemia present, or the manner in which the patient is reacting to the toxemia. If there is a sudden change in atmospheric temperature it is likely to be followed by a change in the patient's temperature. For example; if the weather has been cool and there should be a sudden change, the atmosphere rising 10 or 12 degrees, the body temperature reacts little or much, according to conditions. If the humidity decreases, which it usually does in this section

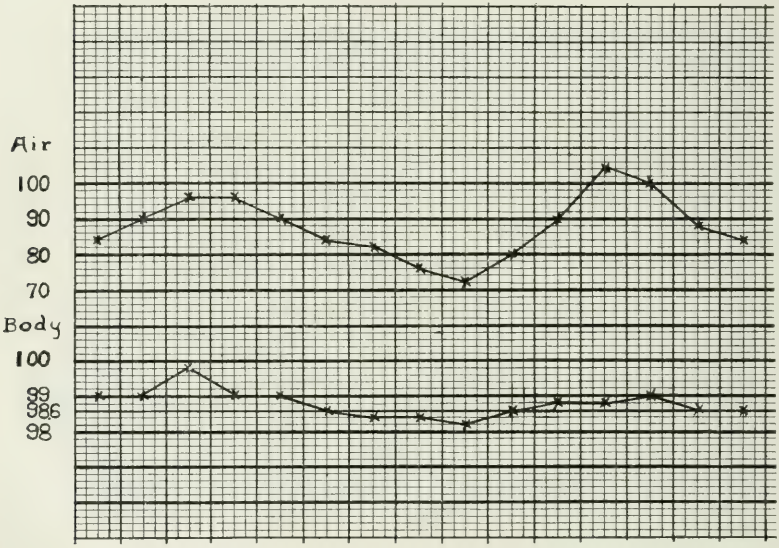

Fig. 123.—Illustrating the influence of atmospheric temperature upon the body temperature. Upper curve, atmospheric temperature; lower curve, body temperature.

when the temperature rises, the rise in body temperature will not be as great as it is if the humidity remains the same, or increases. If the rise in atmospheric temperature is accompanied by wind, the surface of the body is stimulated by this air movement, and, on this account, heat elimination is relatively increased, consequently the rise of body temperature will not be marked. If on the other hand, the rise of atmospheric temperature is accompanied by absence of wind, or air stagnation, then the temperature rises quite markedly. This is particularly noted if the humidity be increased when air stagnation occurs. The temperature of the body varies greatly according to the physical conditions present. It does not depend absolutely upon a rise in atmospheric temperature. As long as atmospheric temperature is below the temperature of the body conditions may be present which may increase heat elimination from the body; but when the atmospheric temperature is above that of the body temperature, the normal factors in heat elimination are seriously interfered with, but compensation is acquired through vasodilatation and perspiration. I have seen atmospheric temperatures as high as 109°, with a humidity of 5 per cent, in which the body temperature of the patient was not influenced as markedly as it is at other times when the atmospheric temperature is below 90°, but the humidity greater.

Another thing noted in relation to the effect of atmospheric temperature upon the body temperature is the fact that if the heat remains for several days, the most marked effect upon the temperature is usually shown during the first or second day. It seems that the heat regulating mechanism is slow of adjustment, and that it requires a day or two for a satisfactory adjustment to be made; consequently, we are very apt to note the highest rise of temperature on the first or second day of hot spells, even though the atmospheric temperature might be higher on the third or fourth day.

The same changes are also noted when the thermometer falls. If the weather has been warm, and it is followed by a sudden drop in temperature, this drop in atmospheric temperature is followed promptly by a reduction in body temperature. What might appear to be an exception to this is noted in patients who, during a sudden drop of temperature, show a tendency to chill. Under such conditions the mechanism of heat production is increased by the rapid contraction of the muscles which occurs during the time when the patient experiences the sensation of chilliness or rigor, as a result of which a rise in temperature ensues. The temperature may go several degrees above that which the patient was showing on the preceding days.

Temperature Curve Due to Complications.—There are many conditions of toxemia, aside from the main tuberculous lesion which produce elevations of the temperature curve. These may be either tuberculous, or non-tuberculous in nature. Examples of the former are curves which mark such complications as pleurisy, infections of the gastrointestinal tract, the larynx, the meninges, the kidney, and, in fact, metastases in any of the organs which become active during the course of chronic tuberculosis. Aside from these, there are many non-tuberculous complications which elevate the temperature curve. Gastrointestinal disturbances, particularly those which are accompanied by constipation or stasis, will afford an opportunity for the absorption of sufficient toxins to produce rise of temperature. The temperature curve, depending upon toxemia of purely gastrointestinal origin cannot always be differentiated from that which occurs during activity in a tuberculous focus. The temperature curve is the same and the other symptoms of toxemia are likewise the same. The absence or lack of cough and expectoration when the toxemia is due to the gastrointestinal tract is the main point of differential value. This is illustrated in Fig. 124. The presence of intestinal toxemia without cough and expectoration caused us to explain the curve as being of intestinal origin.

Sometimes the toxemia accompanying bronchitis, influenza, and even simple cold, will be sufficient to cause a rise in the temperature curve.

Nervous Influences Upon the Temperature Curve.—The effect of nervous influences in causing a rise of temperature has long been recognized. Its explanation, however, has never been satisfactory. Knowing the nerve impulse is not accompanied by rise of temperature, it has been difficult to explain why such conditions as excitement, fear, discouragement, discontent, worry,

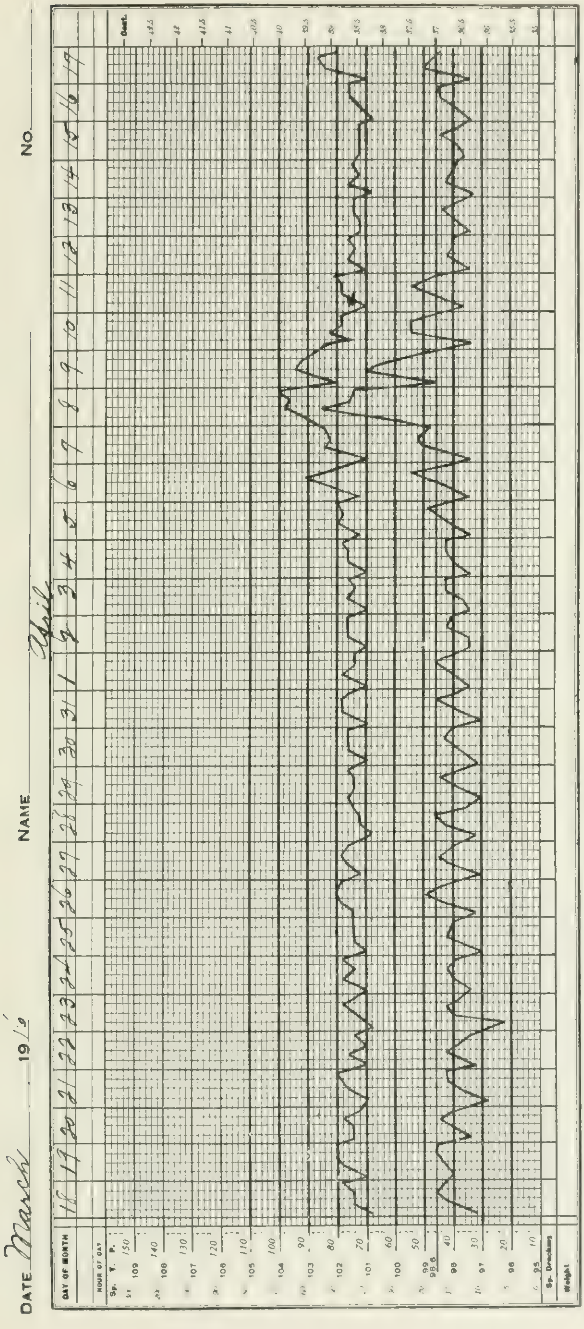

Fig. 124.—Illustrating toxemia with rise in temperature produced by a disturbance on the part of the gastrointestinal tract. Compare this rise with that shown in Fig. 118 and it will be seen that they are almost identical. Upper curve, pulse; lower curve, temperature.

and anger should be accompanied by a rise of temperature. It was not until the effect of these various emotional states upon the sympathetic nervous system was pointed out by physiologists that we could offer a rational explanation of this phenomenon; but we now can readily see that through their action upon the sympathetic nervous system they produce vasomotor disturbance which ends in vasoconstriction and lessened heat elimination, as recently discussed by the writer.[19]

The effect of all these depressive nervous states is the same as toxemia. If they are prolonged they produce a general stimulation through the sympathetic system and not only cause a rise of temperature but produce the same inhibiting influence on the gastrointestinal tract, the same acceleration of the heart beat; in fact, all of the general disturbance which comes from prolonged sympathetic stimulation. This should be explained to the patient that he may see the necessity of avoiding them.

Figs. 125 and 126 (pages 150 and 151) show temperature curves of much the same type; yet the underlying etiological factors are widely different. Fig. 125 is that of a patient who is markedly vagotonic, and at the present time is markedly neurasthenic. The nervous influences can be seen in the pulse record. This patient is suffering from a moderately advanced fibroid tuberculosis without bacilli. She is not toxic, yet her temperature would indicate a marked degree of toxemia. The cause of this rise of temperature, in my opinion, is the nervous influences upon the vasomotor system. Fig. 126, on the other hand, is part of the record of a patient who has suffered from chronic tuberculosis for seven years. He has a widespread fibrosis, large cavities, and marked compensatory emphysema. This patient's disease is active and he suffers from toxemia. The cause of this rise in temperature is the stimulation of the vasomotor system by toxins.

The Effect of Exercise Upon the Temperature Curve.—I have discussed the effect of exercise in general in Chapter XXXVIII. It is very important to understand the effect of exercise upon the temperature curve. The effect of exercise varies according to whether the tuberculosis is active or quiescent. In fact, the test which is sometimes made to determine whether or not active tuberculosis is present, consists in having the patient engage in exercise. If the patient is suffering from active tuberculosis, the effect of exercise is to produce a toxic reaction. This is accompanied by a rise of temperature and other toxic phenomena. If the disease is not active, a slight rise of temperature may occur, but symptoms of toxemia will not manifest themselves. During the periods of active disease, light or moderate exertion raises the temperature curve by increasing the amount of heat produced within the body and at the same time causing constriction of the superficial blood vessels and interfering with heat elimination. Since there is already a disturbance in heat elimination, and this is now exaggerated, the extra amount of temperature produced by the muscular exercise causes the temperature to go higher than it would as a result of either the toxemia or the exercise alone. There are other ill effects from exertion during these times, which have been discussed in Chapter XXXVIII referred to above.

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[19] Fever, A Part of the Syndrome of Toxemia: Vasoconstriction of the Superficial Vessels as an Important Factor in its Production, New York Medical Journal, Aug. 26, 1916.

After the patient has reached the stage where he can exercise without causing an increased toxemia with elevation in the temperature curve, then such exercise can be utilized to the advantage of the patient.

Premenstrual and Menstrual Rise in Temperature Curve.—A disturbance in the temperature curve, associated with the menstrual function has long been observed. This disturbance manifests itself in several different ways. As a rule, there is a rise in temperature prior to the onset of menstruation, and a drop coincident with its appearance. Sometimes a premenstrual rise may not appear but there may be a rise at the time of menstruation, or immediately following it. In many women this rise will come with unusual regularity. For the first fourteen days following the onset of menstruation, the temperature will be low, while, during the succeeding fourteen days it will rise about a half degree. It is not uncommon to find the first fourteen days of the month running from 97.5° or 98° to 98.6° and the last fourteen from 98° or 98.6° to 99°. This menstrual temperature must be recognized, particularly if we are going to lay stress on the rise of a few tenths in temperature as indicat-

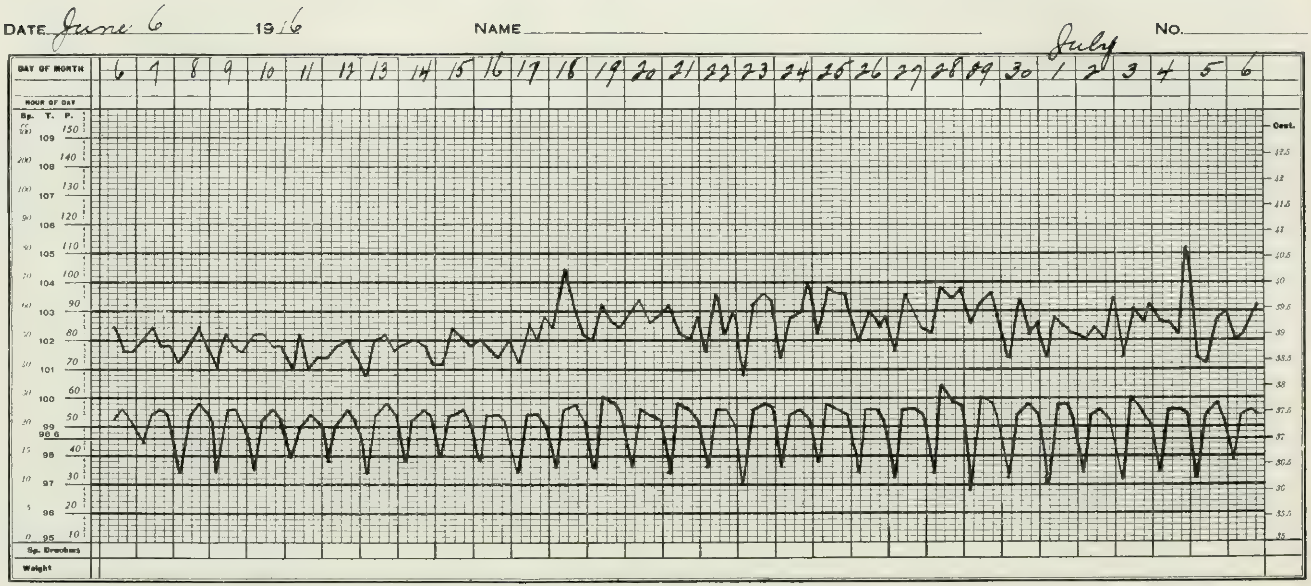

Fig. 125.—Patient suffering from moderately extensive fibroid tuberculosis without toxemia. Temperature curve as well as pulse record markedly influenced by the nervous state of the patient. Contrary to what might be expected from the character of the temperature curve, the patient is not suffering from any of the ordinary symptoms of toxemia. She presents a nervous history extending over many years and is markedly vagotonic; has had a gastroenterostomy done for gastric ulcer. The rise in temperature is apparently due to vasoconstriction due to nervous influences. Compare this chart with Fig. 126, a chronic fibro-ulcerative tuberculosis with moderate activity. Upper curve, pulse; lower curve, temperature.

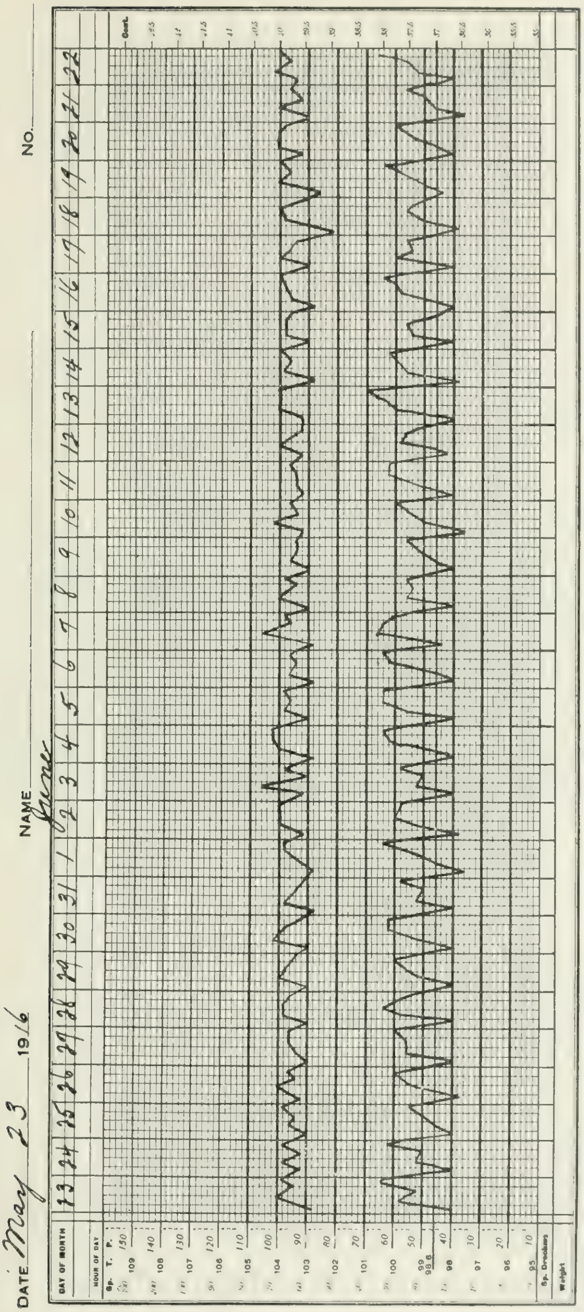

Fig. 126.—Illustrating temperature and pulse curves from a patient suffering from chronic fibro-ulcerative tuberculosis with a moderate degree of activity. Compare this curve with that shown in Fig. 125, which shows a curve similar but due to nervous influences. Upper curve, pulse; lower curve, temperature.

ing active tuberculosis. I have seen these elevations in temperature due to menstrual disturbances, amount to a degree, or more in women who were suffering from a slightly active tuberculosis; and, where markedly active tuberculosis is present, on some occasions, I have seen a rise of three or four degrees; but this is unusual.

Another important observation is that previous to or during menstruation, there seems to be a general lowering of defense. The woman becomes extremely nervous. At times this is associated with an increase in the various symptoms and complications from which patients suffer. If diarrhea is present, it is apt to be worse. If constipation is present, it is apt to be exaggerated. It is not at all uncommon to find patients coughing and expectorating more during this period; and, if one is going through periods of activity with waves of increased and decreased toxemia, increased toxemia is very apt to manifest itself at or near the period time. The expression of disturbance in the vegetative equilibrium is extremely marked in some patients. According to Jobling and Petersen, there is an extra amount of ferment set free at this time.

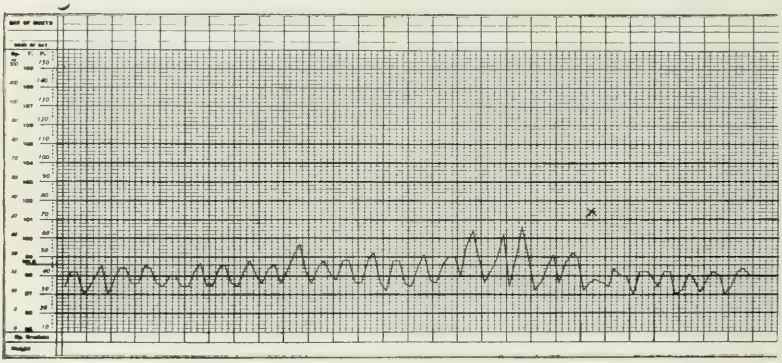

Fig. 127.—Illustrating premenstrual rise in temperature. Prompt drop on day of menstruation; patient suffering from chronic fibro-ulcerative tuberculosis with moderate activity. *X* marks the beginning of menstruation.

A satisfactory explanation of the premenstrual rise of temperature has not been offered, as far as I know, up to this time. It seems to me, however, that our studies of internal secretions afford us a clue. It has been shown that the secretion from the

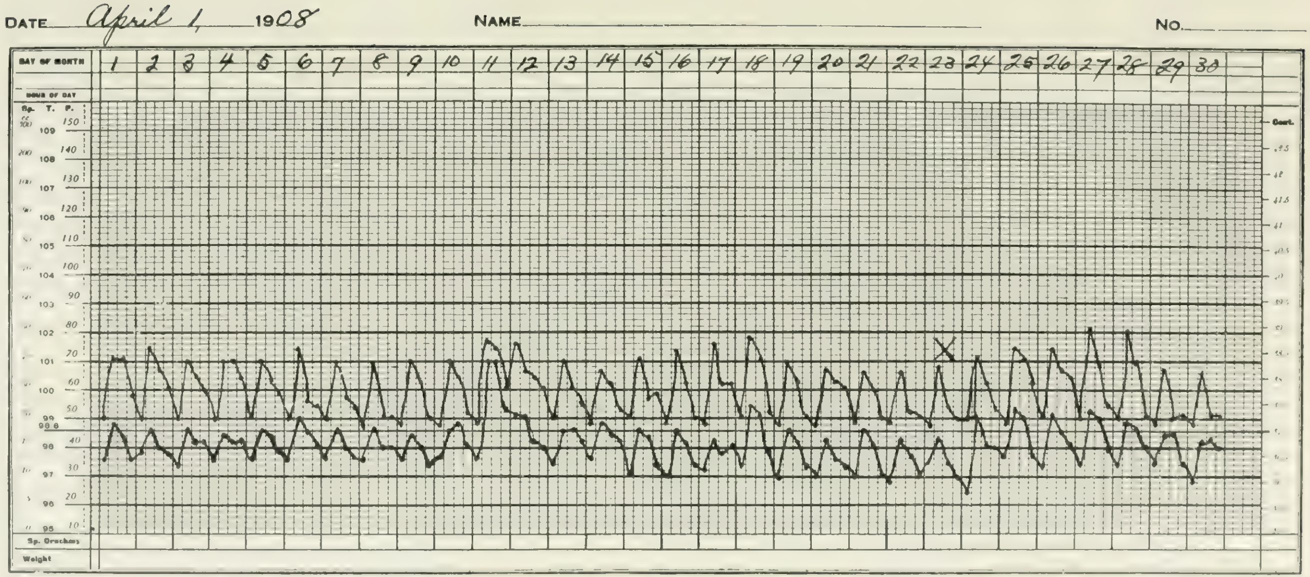

Fig. 128.—Illustrating rise in temperature during and following menstruation. Onset of menstruation marked by X. This patient was markedly vagotonic as is indicated by the slow pulse. This patient also suffered from other symptoms of vagotonia, thus: hay fever, asthma, hyperacidity, and spastic constipation. Upper curve, pulse; lower curve, temperature.

testicle produces stimulation of the sympathetic nervous system.[20] One of the effects of such stimulation, as seen from our previous discussion, is to stimulate vasoconstriction, thus interfering with heat elimination. The probabilities are that the secretion from the ovary is of the same character; and, inasmuch as there is more or less activity in this organ at this time, it seems but natural to offer as a theory that this premenstrual rise in temperature is due to vasomotor stimulation as a result of the ovarian secretion. Figs. 127 and 128, pages 152 and 153, illustrate two types of menstrual and premenstrual rise.

Other Factors Commonly Influencing the Temperature Curve.—I have described elsewhere how eating a hearty meal affects a physiological rise of temperature during the time that the extra quantities of food are being oxidized. This may be accompanied by a feeling of discomfort and sometimes by headache and feelings of languor; but other common symptoms of toxemia do not appear.

Conditions which influence the surface of the body are prone to change the temperature curve. For example, a change which is commonly noted is that following a bath. Oftentimes, when a bath is given, the patient is inclined to chill, resulting in increased vasoconstriction. Even with or without the patient's feeling chilly, a rise of temperature occurs during the next few hours. This is seen quite often in patients of low vitality who are suffering from severe toxemia. The same thing may be noted if the patient is exposed to currents of wind. A feeling of chilliness may be present, or simply a lowering of the temperature curve may take place. I have seen this produced artificially by the use of an electric fan, where, by throwing the stream of cold air on the patient, the temperature curve has been kept quite low. Such air movement, however, is very apt, if the patient's reactive powers are good, to stimulate the force of heat production and raise the temperature later.

Posture has considerable to do with the temperature curve. Patients sometimes make the observation that when they lie down their temperature is a few tenths higher than when they are standing up. The explanation of this is simple. When the patient is lying down, with his mouth near the same level as the heart, there is more blood circulating in the vessels than when he is standing up, with gravity against the blood column.

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[20] Homer Wheelon: Extirpation of the Testes and Vasomotor Irritability, American Journal of Physiology, 1914, vol. xxxv, p. 283; and Homer Wheelon and J. L. Shipley: The Effects of Testicular Transplants Upon Vasomotor Irritability, American Journal of Physiology, 1916, vol. xxxix, p. 394.

Excessive covering will often produce a rise of temperature. Patients who lie down and cover themselves with an excessive amount of covering interfere with the dissipation of heat and in this way cause a rise in body temperature. Patients sometimes find that when they have been sleeping, snugly covered, they awaken with a higher temperature than when they remain awake. Wrong conclusions are often drawn from not understanding these tendencies to change in the temperature curve. In fact, too much stress is laid on the temperature of our tuberculous patients. They become temporarily hypochondriacal at times and worry over slight changes in temperature which are purely physiological. I have great difficulty at times in convincing nervous patients that the rises in temperature which they have are due to nerve stimulation. This is due to the teaching that rises in temperature mean activity. Patients sometimes think that they should not lie down because their temperature is a little higher when reclining than when sitting up. They often suggest that they do not want to sleep in the afternoon because they find their temperature is a few tenths higher than when they go without sleep.

Sometimes a difference in temperature is noted on the two sides of the mouth. On the side of involvement during periods of activity a vasodilatation takes place. This I have explained as approaching a vasomotor paralysis, and being dependent upon two factors,—first, the reflex stimulation of the vasomotors on the side of the involvement through the sympathetics, and, second, the general toxic effect upon the same. I have called attention (Vol. I, p. 199) to the fact that the vasodilatation which produces the common hectic flush does not occur until a certain degree of toxemia is present, and have explained it as being due to overstimulation resulting in a dilatation of the vessels, resulting from a condition which approaches vasomotor paralysis. This same condition occurs in the mouth on the side of involvement. In one or two cases where I had a record kept for a prolonged period of time I found that the temperature of the side of the mouth in the patient in whom a marked vasodilatation occurred, registered the same as that of the rectum. Dilatation of the vessels of the mouth may occur as a parasympathetic reflex, the impulse coursing centralward over the sensory fibers of the pulmonary vagus, the dilator effect being produced by the trigeminus (Vth cranial) nerve.

We must not forget that during the course of tuberculosis tubercle bacilli probably gain access to the blood stream more or less frequently. If large numbers enter the circulation and meet rapid destruction, sufficient tubercle protein could be liberated to produce definite toxic reaction. Under such circumstances, a rise in temperature similar to a tuberculin reaction must take place. How often this occurs, we do not know, but I have often thought that probably many of our indefinite temperature reactions for which we are unable to find an adequate explanation may be due to this cause.

Unless we understand these little things which occur in the life of every patient and affect the temperature curve we may draw wrong conclusions regarding the disease itself.

CHAPTER XXXI.

ANAPHYLAXIS.

One of the most interesting phenomena associated with the immunity reactions is anaphylaxis. Anaphylaxis may be described as being a manifestation of a condition of sensitization of the body cells to foreign protein. This condition holds a very important place in the field of medicine today, and bids fair to explain many clinical reactions which have hitherto been inexplainable. Among such phenomena may be mentioned urticaria, some cases of hay fever and asthma, the diarrheas which follow the use of shell-fish, and probably eczema. The symptomatology of anaphylaxis has been fairly well worked out by Otto, Rosenau and Anderson, Wolff-Eisner, Gay and Southard, Friedman, and Friedberger, as well as many others.

Relationship of Anaphylaxis to the Vegetative Nervous System.—I wish to confine my discussion largely to the relationship which anaphylaxis bears to the vegetative nervous system. Discussions of other phases of the subject can be found in modern journals devoted to immunology. A knowledge of the vegetative nervous system is fundamental to an understanding of the phenomena which occur as a result of the parenteral introduction of protein into the body. The principle of action and counteraction is everywhere present in the body. In the somatic muscles we have flexors and extensors. In the blood vessels we have vasodilatation and vasoconstriction. In breathing we have inspiratory and expiratory effort. In the musculature of the internal viscera we have increased muscular action, and inhibition of this action. In the glands we have secretory activity and inhibition of this activity. All of those functions of the body which are not presided over by the will belong to the field of the vegetative nervous system. This system, as discussed more fully in Volume I, Chapter VII, may be divided into two great divisions,—the sympathetic and the parasympathetic. The sympathetic comprises all cells of the vegetative system which have passed out from the central nervous system from the thoracic and upper lumbar segments of the cord. The parasympathetic comprises those which have passed out from the cranial and bulbar, and lower lumbar and sacral portions of the cord. Recalling our physiology, almost without exception, internal viscera are supplied by both of these divisions of the vegetative system; and, wherever these two divisions meet in a given organ, their action is antagonistic. To illustrate,—in the respiratory system, bronchial spasm is produced by stimulation of the vagus (parasympathetic); and relaxed by sympathetic stimulation. The heart beat is slowed by vagus stimulation, and increased in rapidity by sympathetic stimulation. The secretion of the glands of the bronchi, stomach, intestines, and likewise that from the liver and pancreas, is increased by vagus stimulation, and decreased by sympathetic stimulation. Motility of the stomach and intestines is increased by vagus stimulation and decreased by sympathetic stimulation. The anal and urinary sphincters are contracted by sympathetic stimulation, and relaxed by vagus stimulation. The same is true of the ileocecal valve.

Syndrome of Toxemia and Anaphylaxis Contrasted.—It is important to understand this relationship if we would understand the action of protein poisoning. Vaughan has shown us that protein may be divided into two molecules,—one of which he calls the sensitizing, and the other the toxic. If we study the two states, toxemia and anaphylaxis, from their relationship to the sympathetic and parasympathetic divisions of the vegetative nervous system, we can see that they are different. Toxemia acts centrally and expresses itself peripherally through the sympathetic system. This syndrome differs in detail accordingly as the toxemia is acute, or chronic in nature, and also according to the degree of toxemia present. The syndrome of anaphylaxis, on the other hand, is that of peripheral stimulation expressing itself through the parasympathetic. It likewise differs according to its acuteness and severity. We can better understand the antagonistic relationship of acute toxemia and acute anaphylaxis, if we first consider and contrast the phenomena which accompany chronic toxemia and chronic anaphylaxis. The anaphylactic reaction may be prevented by previous injection of atropin. Its peripheral origin is shown by the fact that it still manifests itself when the medulla and cord have been destroyed, and the vagi divided.[1]

Toxemia of moderate degree, whether it be acute or chronic, produces a syndrome which is characteristic of central nerve stimulation, increased endocrine secretion and increased action on the part of those structures supplied by the sympathetics:

Dilatation of the pupil.
Lack of appetite.
Deficient secretion of gastric juice.
Deficiency in intestinal secretion.
Deficient secretion in liver and pancreas.
Lessened motility of the gastrointestinal tract.
Rapid heart's action.

Fever (being due to interference with elimination of heat, caused by toxins producing the vasoconstrictor effect through the sympathetics, as discussed in Chapter XXX, as well as to increased heat production).

If the toxemia be very severe, the syndrome differs. Aside from the general inhibition of function such as mentioned above, we have marked central stimulation and an approach to paralysis of the sympathetics, as shown in the following symptoms:

Vasodilatation.
Fall in blood pressure.
Fall in temperature.
Sweating.
Collapse.

Anaphylaxis, on the other hand, shows as peripheral irritation manifesting itself in the parasympathetics. Chronic anaphylaxis shows this particularly well. Very common symptoms belonging to this syndrome are:

Bronchial spasm.
Increased bronchial secretion.
Nausea.
Vomiting.
Diarrhea.

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[1] Auer and Lewis: Journal American Medical Association, 1909, vol. liii; Journal Experimental Medicine, 1910, vol. xii.

Itching of the skin (the exact explanation of this I cannot yet give).

Blotching of the skin (a common symptom in patients who are markedly vagotonic).

Severe anaphylaxis shows the following symptoms in addition to the above:

Increased motility of the intestinal tract with relaxation of the sphincter resulting in involuntary discharge of feces.

Increased activity of the musculature of the bladder, with relaxation of the sphincter, resulting in incontinence of urine.

Perspiration.

Low blood pressure.

Fall in temperature.

Collapse.

It will thus be seen that the syndrome of severe or fatal anaphylaxis, and that of severe or fatal toxemia, is practically the same. The more chronic symptoms, however, are indicative of action of different divisions of the vegetative system. Fall in temperature, fall in blood pressure, sweating and collapse of severe toxemia, will result from severe stimulation of the higher brain centers or excessive stimulation of the sympathetics, resulting in a state approaching paralysis of the vasomotors. These same symptoms, resulting from a fatal anaphylaxis might be taken as indication of central irritation plus marked parasympathetic stimulation. It is probably wrong to account for the syndrome of severe and fatal toxemia, and severe and fatal anaphylaxis as being wholly expressions of excessive stimulation of either the parasympathetic or the sympathetic. When such severe reactions occur, undoubtedly the entire organism is involved, and the resultant syndrome is probably of much wider extent than stimulation of either of these important divisions of the vegetative system alone. It is most probable that there is a widespread injury to the cells of the entire central nervous system.

While we cannot explain satisfactorily the syndrome of fatal anaphylaxis and fatal toxemia in their relationship to these two divisions of the vegetative system, if we turn to chronic anaphylaxis, as represented in some of our common affections, the picture is quite clear. Hay fever shows the following symptomatology due to parasympathetic stimulation—increased lachrymation, increased secretion of the nasal mucous membrane, sneezing. Bronchial asthma shows increased bronchial secretion, bronchial spasm and cough. In shell-fish poisoning we have a diarrhea due to excessive stimulation of the vagus, producing hypermotility of the gastrointestinal tract. The same hypermotility results in nausea and vomiting which are also common accompaniments.

It can be seen that in contrasting these symptoms of anaphylaxis with those of toxemia, we have an entirely different picture. The antagonism between toxemia and anaphylaxis has also been demonstrated in the writer's experience in a case of asthma in a patient suffering from active tuberculosis, who experienced complete relief from severe asthmatic paroxysms which had existed several days, by climbing a mountain and producing marked toxemia with high fever; also by another experience where a siege of asthma was lessened in severity by a tuberculin reaction which resulted in the induction of a toxic state with fever.

The parenteral introduction of protein into the body may at one time result in the syndrome of toxemia and, at another, in the syndrome of anaphylaxis. Which syndrome will appear will probably depend on three factors—the amount of specific enzymes present, the relative amount of toxic and anaphylactic molecules liberated; together with the rapidity of their liberation; and the relative natural tonus of the sympathetic and parasympathetic systems shown by the individual receiving the inoculation. The idea which I wish to convey is the one which has been worked out by Eppinger and Hess, that of individuals naturally being vagotonic or sympatheticotonic. Clinically, we see many patients who have parasympathetic tonus uppermost, who react readily to parasympathetic stimulation. We see many others, on the other hand, in whom sympathetic tonus is uppermost, and who show the syndrome which follows sympathetic stimulation. This is unquestionably a factor in determining the result which follows a parenteral introduction of the protein into the body and we must not lose sight of it in practice.

Robert A. Cooke and Albert Vander Veer, Jr.[2] have made a study of pollen sensitization and shown by the analysis of 621 cases that there were 504 in whom it seemed to be an inherited condition. This, taken in conjunction with the work of Eppinger and Hess, and with our clinical observations that vagotonia seems to go in families and to be handed down through offspring, would indicate that the nervous system which we inherit is probably a big factor in determining whether or not a patient is to show anaphylactic phenomena. We find various combinations of such conditions as hay fever, hyperacidity, spastic constipation, and bronchial asthma, affecting the same patient very frequently.

Anaphylaxis in Its Relationship to Tuberculin Reactions.—Since our studies of anaphylaxis, we have been accepting the fact as practically settled that the tuberculin reaction and the anaphylactic reaction are the same. I have discussed this in treating of tuberculin in Chapter XL, but wish to repeat a certain portion of my discussion here.

As a basis for understanding the reaction of tuberculin, I accept Vaughan's work as showing how the tubercle protein, the same as all other proteins, may be divided into toxic nonspecific and sensitizing specific molecules. When we consider this in connection with their respective actions upon the sympathetic and parasympathetic divisions of the vegetative nervous system, as described above, we have a new viewpoint which enables us to explain more fully than heretofore, the reactions which we observe in the employment of tuberculin.

The syndrome of anaphylaxis is but rarely met with in the administration of tuberculin. The toxic syndrome, however, is met rather commonly when tuberculin is administered hypodermically; and local evidences of sensitization in the form of local, needle track and focal reactions, are commonly seen in connection with its administration. One reason that we do not obtain a degree of anaphylaxis like that noted after the injection of horse serum is probably due to the fact that every patient who suffers from tuberculosis, has received gradual inoculations of a protein so nearly identical with the one that we are administering in our tuberculin, that he has become desensitized; and, consequently, does not readily show the phenomena of anaphylaxis, which can be produced at will in animals which have not been previously injected with a given protein. As I have suggested elsewhere in these pages, the toxic raction in tuberculin depends upon two things,—first, the amount of tuberculin introduced; second, the amount of specific enzymes present and the rapidity with which the tuberculin is broken up by them into toxic and sensitizing molecules. If the toxic molecules are set free in sufficient amounts with sufficient rapidity, the toxic action is manifested by the usual syndrome of toxemia, which is recognized as the tuberculin reaction; if, on the other hand, cleavage is slow, and the toxic molecules are set free slowly, they may be further elaborated and robbed of their toxic effect.

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[2] Human Sensitization, Journal of Immunology, June, 1916, vol. i, No. 3.

The method in which the protein is introduced into the tissues determines largely whether or not anaphylactic symptoms will appear. If it is introduced in small amounts infrequently, allowing from a week to two weeks to intervene between dosage, anaphylaxis will appear after four or five doses have been given in a large percentage of cases. If, on the other hand, the injections are given with a short interval between, and the amount of protein is gradually increased, a desensitization will take place and anaphylactic symptoms will not appear. This principle should always be taken into account in the administration of tuberculin, even in spite of the fact that the patient is already desensitized, as previously mentioned.

CHAPTER XXXII.

ASTHMA.

Asthma in Its Relationship to Tuberculosis.—It is not my intention to give a complete description of asthma, but to endeavor to counteract some of the common ideas which are held as to its relationship to tuberculosis, and also to suggest a few points bearing upon its etiology.

Etiology.—Powell and Hartley[1] speak of asthma as being attributed to an inherited predisposition, and as having a neurotic family history, and have divided the exciting causes of asthma into those of direct, reflex, and central. As direct causes, they discuss such things as inorganic dust, vapor, inflammatory chest affections, especially bronchitis, and atmospheric influences. As reflex, they note many different conditions in the gastro-intestinal tract, such as distention of the stomach or bowels, loaded colon, and intestinal parasites. They also call attention to asthma being produced by such irritation of the nasal mucous membrane as that resulting from polypi. They recognize a reflex irritation from the uterus, also one from excitation of the cutaneous nerves. They further discuss the effect of stimulation of the medullary center by various irritants. For example, they conceive that the products of incomplete digestion might give rise to an attack in this manner, and that an excess of carbonic acid in the blood might produce asthma. They speak of asthma, at times, being connected with emotions.

It is impossible to discuss the etiology without taking into consideration the symptomatology of asthma. The symptomatology of asthma is definite. It consists of:

Bronchial spasm.
Increased bronchial secretion.
Cough.
Dyspnea.
Eosinophilia in sputum.

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[1] Diseases of the Lungs, Fifth Edition, London, 1911.

These symptoms result from stimulation of the parasympathetics. We have been inclined to think that they might be produced either by central or peripheral stimulation, but the work of Auer and Lewis mentioned in the preceding chapter indicates that anaphylactic phenomena are of peripheral origin. This work, however, does not show that they could not also be due to central stimulation.

The relationship between asthma and irritation in the gastrointestinal tract is emphasized by the fact of the close developmental relationship between the lung and the gastrointestinal tract. It will be recalled that the lungs are made from a diverticulum which originates in the gastrointestinal tract; consequently, have the same innervation.

Our studies of the relationship between the vegetative nervous system in tuberculosis and the clinical phenomena observed during the course of the disease, particularly the reflexes which manifest themselves in the different branches of the parasympathetics, prepare us to accept, as a fact, that stimulation of the fibers of any branch of the parasympathetic system which may be connected directly or reflexly with the branches of the pulmonary vagus may result in asthma. At one time asthma may result reflexly from irritation of the branches of the parasympathetic which supply the nasal mucous membrane or the accessory sinuses; again it may result from irritation of the cardiac branches. It frequently results from irritation of the gastrointestinal branches. The reflexes arising from the sacral portion of the parasympathetics and coming from irritation in the uterus and its appendages, and the urinary tract, are somewhat more difficult to explain. These can be explained, however, in the same manner as nausea and vomiting which result reflexly from these same organs; that is, by the fact of there being a communication through the cord between the parasympathetic centers in the cranial and bulbar portions of the cord and those in the lower lumbar and sacral divisions. It is also produced by direct stimulation of the pulmonary branches of the vagus as we see it develop in pulmonary tuberculosis.

Aside from such instances as mentioned above, where inflammation of the parasympathetic in one viscus stimulates the pulmonary vagus reflexly, or where it is stimulated directly we have asthma at times as a result of protein poisoning. Whether this action is central or peripheral, we do not know. Protein poisoning, however, expresses itself at one time in one branch of the parasympathetics and, at another time, in another. The relationship of protein to asthma has been suggested by many clinicians who have attempted to eliminate the cause by reducing the amount of protein in the food, believing that the absorption of the protein from the intestinal tract was the main factor. This may be true; but, it is entirely possible that asthma may be produced by protein absorbed through the mucous membrane of the air passages.

From this discussion we can see that asthma is not a disease. *Asthma is a disturbance in function. It is an increase in tonus of that portion of the parasympathetics which supplies the bronchial mucous membrane. Its cause may be as diverse as the irritants which may be applied to its nerve centers which give origin to the pulmonary fibers, or to the peripheral nerves that are in reflex relationship with them.* As all toxemias which are sufficiently severe may produce the toxic syndrome, so all irritations, either reflex or central which produce sufficient stimulation of the nerve cells giving origin to the pulmonary filaments of the vagus may produce asthma.

My observation seems to show that asthma rarely occurs except in those patients who are distinctly vagotonic. Patients with asthma nearly always show other symptoms of increased parasympathetic tonus. They often have some combination of the following conditions: hay fever, urticaria, hyperacidity, spastic constipation, and perspire easily on excitement. Asthma, however, may be produced at times in individuals who are not distinctly of this type. I have seen asthma come on in patients who had attained a favorable result in pulmonary tuberculosis, where there was a marked fibrosis, which probably resulted in irritation of the vagus nerve. Contrary to the usual opinion that a person with tuberculosis does not have asthma, at the present time, of seventy-five patients in the Pottenger Sanatorium, seven of them suffer from asthma.

Treatment of Asthma.—The treatment of asthma consists in relieving vagus irritation. There are two remedies which have direct action in opposing vagus stimulation. These are adrenin and atropin. Experimentally these have been used in asthma for many years and have proved to have direct therapeutic worth. It is only now that we understand their action that we can see the method in which they produce their effect. Atropin is the best remedy that we have for the direct counteraction of vagus stimulation. Adrenin acts by stimulating the sympathetics; and by increasing the sympathetic tonus, it causes the sympathetic nerves themselves to overcome the vagus stimulation; and, in this way it brings about a relaxation of the spasm of the bronchial musculature and a decrease in the production of bronchial secretion.

The true vagus nature of asthma and its control by sympathetic stimulation is illustrated by the relief from paroxysms afforded by an intercurrent toxemia. I have recently had three instances of this kind come to my notice. One patient was relieved by an attack of acute tonsillitis; another by a pneumonia; and a third by a toxemia produced by a very marked overexertion, the patient being tuberculous and suffering from a marked toxemia, with rise of temperature as a result of mountain climbing. The toxemia, if sufficiently severe, stimulates the sympathetics sufficiently to overcome the extra vagus tonus.

All sources of irritation which are capable of producing reflex stimulation of the pulmonary vagus should be searched for and relieved if possible. This may be in one of the accessory sinuses, the nasal chamber, the heart, the lower respiratory tract, or the gastrointestinal tract. Peripheral irritation from protein molecules deposited in the tissues (Vaughan) must also be remembered as a possibility. Lastly, the tendency of some individuals to be markedly vagotonic and have the equilibrium of their vegetative nervous system disturbed in such a manner as to produce the syndrome of vagotonia, must ever be borne in mind. Vagotonia is not always general. It frequently expresses itself in some one branch. Such cases should be helped by treating the general condition, building the patient up, and relieving him from all undue nervous and physical strain.

CHAPTER XXXIII.

PULMONARY HEMORRHAGE.

When we consider that pulmonary tuberculosis is a disease affecting the parenchyma of the lung, which is a veritable network of blood vessels, it seems strange that any patient suffering from this destructive disease could escape hemorrhage. That they do is owing to the fact that while tuberculosis is a chronic inflammation accompanied by necrosis, an inflammatory process usually precedes the necrosis. The blood vessels take part in the inflammation; their walls thicken; a thrombosis forms, obliterating the lumen, and bleeding is forestalled before the vessels are affected by the necrotic process.

The frequency of this complication depends a great deal on the character of the patients observed, being less common in early cases and more frequent in the advanced ones. Some degree of bleeding is probably found in three-fourths of all cases at some time during the course of the disease.

Amount of Hemorrhage.—Bleeding from the lungs may come in amounts varying from streaks in the sputum to fatal hemorrhages in which sometimes two or three pints of blood are lost. Even the large hemorrhages, as a rule, are not as large as the patient believes.

Cause of Hemorrhage.—It is usually believed that hemorrhage is due to overexertion; but, in my experience, the greatest number of hemorrhages have come while the patients were lying in bed, even some of the fatal hemorrhages have appeared in the middle of the night, the patient awakening with the taste of blood in the mouth, and expiring within a few minutes. At times hemorrhages follow overexertion, such as lifting weights, running for a car, climbing mountains, or other strenuous physical exercise. While exertion may be the determining cause, the real cause of the hemorrhage is the pathological condition affecting the vessel walls. If an aneurism, or an ulceration of the vessel wall is present, a rupture may occur at any time; and, as my experience shows, the greatest proportion of hemorrhages come on while the patient is in bed, it would seem to me that the real cause of hemorrhage is the slowly destructive process in the vessel wall, which reaches the point of rupture as a natural course. Most hemorrhages that come on following exertion, as mentioned above, probably would have been delayed for a time had the patient avoided the exertion, but they probably would have come on later just the same.

Blood Spitting as an Early Sign of Tuberculosis.—Spitting of blood is quite commonly the first symptom to call attention to the fact that a patient has tuberculosis. In a former discussion[1] of this subject the writer stated: "There is only one excuse for not giving a patient who suffers from an early hemoptysis the benefit of an early diagnosis and early treatment, and that is a failure on his part to consult a physician. 'Throat hemorrhage' has become almost obsolete, 'stomach hemorrhage' is extremely rare, but 'pulmonary hemorrhage' has gained in importance because we now know that nearly all hemorrhages formerly attributed to other causes are due to a bleeding from some point within the lung."

These early hemorrhages may be the first sign of a disturbance in an old apparently healed focus. Again, they may be due to a slight localized softening following an extension of the trouble. The early symptoms of tuberculosis are so insidious that very often the patient does not realize that he is suffering from so serious a disease as tuberculosis until after his attention has been called to it by blood spitting. Then he recalls that he has suffered from some of the nervous symptoms,—those of malaise, lack of endurance, and probably irritability for some time preceding. He may have found that his work tired him more than usual. In such cases the diagnosis would probably not be made until later if the blood did not appear; consequently, blood spitting, as an early sign, should be welcome.

In the classification of symptoms (Vol. I, p. 390) I have dwelt upon the importance of this sign as being one due to the tuberculous process *per se,* and pointing directly to the lung as the part diseased. Patients who suffer from blood spitting early should have a diagnosis of pulmonary tuberculosis made without question, and should be directed in the right path for an arrestment to result.

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[1] Pulmonary Tuberculosis, William Wood & Company, New York, 1908.

Spitting of blood, when other evident causes have been ruled out, should, without other data, make the diagnosis of pulmonary tuberculosis with no greater margin of error than our most approved laboratory tests diagnose other diseases; so why wait for other signs and symptoms?

Hemorrhages Appear in Groups.—The most striking feature of pulmonary hemorrhages to me, as I have observed them in my sanatorium experience is the fact that they come in groups. There will at times be periods of considerable length when there are no instances of blood spitting. At other times we will find from five to ten per cent of the patients showing color in varying amounts at the same time. My former associate, Doctor Charles C. Browning,[2] made a study of this and reported it to the American Climatological Association in 1908. ''Blood spitting'' among the symptoms of tuberculosis is not unique in this feature. We find that the same is true of pleurisy, neuritis, and nervous irritability. They seem to be associated with climatic and meteorological changes. Whether it is due to the influence of the barometer, or to conditions which are present at the time that the barometer is changing, I do not know. It might be due to the physical effect of the air upon the body surface, causing reflex disturbance in the pulmonary blood vessels through the sympathetics. I state this more as an inquiry than as an opinion.

We note that hemorrhage is prone to occur during foggy weather and rainy weather; also during extremely dry weather. The principal factors in common in foggy weather and rainy weather, as we find it here in California, are probably cold accompanied by dampness. This would have a tendency to chill the surface and drive the blood inward. Cold accompanied by dampness is not a factor, however, in extremely dry weather, for the hemorrhages appear in summer the same as in winter. Most of these hemorrhages that come in groups are slight; yet not infrequently, we see very extensive bleeding under these same conditions. The spitting, at most, of a few mouthfuls of blood, is far more common than hemorrhages amounting to a half ounce or more. These hemorrhages belong to type four.

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[2] The Effect of Climatic Conditions on Important Symptoms in Tuberculosis, Trans. American Climatological Association, 1908.

Studies made in the Phipps Institute a few years ago called attention to the pneumococcus as being a causative factor in pulmonary hemorrhage. I have seen hemorrhages during epidemics of acute respiratory diseases. While it was impossible to determine that the prevailing infection was a cause, yet it was necessary to bear it in mind as a possible factor. More recently I observed a hemorrhage in a patient with acute tonsillitis, in which I could not help thinking that the infection probably stood in an etiological relationship.

Types of Hemorrhage.—In a former paper[3] I suggested that hemorrhages might be classed in four groups. First, frank hemorrhage, coming on suddenly without previous warning, where a vessel of some size is opened and the blood flows out freely. This type is one that is apt to be followed by a fatal result. The blood comes up into the mouth as fast as the patient can expectorate it; and, in severe cases, faster; often causing the immediate death of the patient. In some cases there is considerable blood expelled. In other instances the blood trickles down in the lung and suffocates the patient without outward evidence of hemorrhage. I have seen a number of patients die of hemorrhage; some of whom expelled only a few mouthfuls of blood, while others expelled large quantities. The blood in these cases usually comes from eroded vessels or ruptured aneurisms. The arteries withstand the necrotic process in tuberculosis, and also resist obliteration better than the veins; consequently, cavities with patulous arteries crossing them, are often found. The support of the pulmonary tissue having been removed, the vessel walls yield sooner or later causing aneurismal dilatations, which now and then rupture, causing these large hemorrhages.

While severe hemorrhages may be due to either a rupture of an aneurism, or an erosion of a vessel, the former is by far the more common. In eighty postmortems following fatal hemorrhage, made by Percy Kidd, ruptured aneurism was found in seventy. The cause of aneurism is the weakening of the vessel wall either because of the lack of support or because of an extension of the tuberculous inflammation. This condition is shown in Fig. 5, Volume I. At other times a tubercle in the walls of the artery breaks down and permits the escape of blood. The amount of bleeding under such circumstances depends considerably upon the size of the vessel involved and the extent of the rupture in its wall. If the rupture is small, bleeding may be checked by the formation of clot and repair may quickly go on. If, on the other hand, the rupture is large, even though a clot may form, causing a temporary cessation of bleeding, it is apt to be followed by a renewal of the hemorrhage before the rupture can be repaired. This type of hemorrhage frequently comes on suddenly. Three of my own patients died recently of this type of hemorrhage. All were making satisfactory progress toward arrestment, and expressed themselves on the day of their death as feeling better than they had felt for months. This type of fatal hemorrhage is more apt to occur in older subjects with hardened arteries.

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[3] Some Observations on the Classification and Treatment of Hemoptysis, American Journal of Medical Sciences, June, 1914.

Sometimes fatal hemorrhages are preceded for several days by the presence of small quantities of blood in the sputum. This type of hemorrhage is the most severe we have to handle; and even those instances which do not prove fatal usually result in pneumonia, and are often followed by a spreading of the disease, or some other serious effect on the patient.

Death following hemorrhage is at times due to cerebral anemia,—the loss of blood, and the shock, probably both being factors. To avoid the anemia, it is best for the patient to lie down, although there is a feeling on the part of the patient that he must sit up in order to be able to expel the blood. A feeling of suffocation is also increased by the recumbent position.

The second type of hemorrhage is that which comes on coincident with the expulsion of necrotic tuberculous masses. Such hemorrhages are usually preceded by several days' rise of temperature, and other symptoms which commonly accompany such acute processes.

The real cause of bleeding in these cases is that the destructive process goes on so rapidly that rupture occurs before the lumen of the vessel is obliterated. As mentioned above an obliterating endarteritis with resultant thrombosis nearly always takes place before necrosis occurs; but, in these cases, it fails to do so. This type of hemorrhage usually involves small vessels, although, at times, large hemorrhages occur; and, in a few instances, I have seen them prove fatal. The amount of blood lost is usually a few mouthfuls. The blood is expectorated on several succeeding days. This type of bleeding is very different from the preceding type, and offers a much better opportunity for relief. Following this type of hemorrhage the patient often feels very much better; in fact, he sometimes attributes his improvement to the hemorrhage. This is erroneous. The reason he feels better is because he has experienced a relief from toxemia in getting rid of the tuberculous mass. Hemorrhage was merely an accident in an acute process which put an end to the cause of increased toxemia; so it does not deserve the credit that is often given it.

After active bleeding in hemorrhages of the first and second types has ceased, blood will continue to appear in the sputum until the bronchi are cleared. In a few days after the hemorrhage has occurred the clot softens and is expectorated more easily. In some cases it will take a week, or even longer, after a severe hemorrhage before it is all cleared out. At first it is dark red; then it finally loses its reddish tinge and becomes brownish. In a few instances, where the blood clots very rapidly, casts of the bronchial tree are produced and coughed up. In one of my patients nine casts of bronchi of the second and third order were cast out within a few days following a severe hemorrhage.

The third type of hemorrhage is that where the blood comes from very tiny vessels in a cavity. The walls of the cavity are sometimes lined with delicate vessels,—so delicate that even the removal of sputum or coughing will rupture them. This type of bleeding is usually recognized by the fact that the blood is thoroughly mixed with the pus coming from the cavity. Instead of the blood being either dark or bright, it has a pinkish hue and is mixed with pus. I usually look upon this as indicative of new tissue formation in a cavity and take it to be a condition favorable to healing. This sometimes shows with only one or two expectorations. At other times, it may last for several days.

Before taking up the next type of hemorrhage I wish to call attention to the fact that the three types above mentioned all belong to one class etiologically,—all have the common characteristic that they are due to a rupture in a vessel wall, the difference in type depending on the size of the vessel and the extent of the rupture. These hemorrhages being due to an open vessel, all require much the same therapy, as will be discussed later.

The fourth type of hemorrhage is that where the patient usually expectorates a mouthful or more of blood at a time. This may stop after expectorating a small quantity of blood or continue bleeding over a period of several days or weeks. There is rarely large quantities at a time, and the main danger from such a hemorrhage is its long continuation. The blood, as a rule, does not present the same characteristics as it does when coming from an open vessel. It is usually dark and comes up, partially clotted. In the paper referred to above, I said: "I look upon this type as being due to a congestion, much the same as we see in pneumonia and heart lesions. Is it not possible, however, that it might be due to toxic action?" The theory of toxic action seems to me to be the one which offers the best explanation. Such types of hemorrhage rarely occur except where the disease is active. It is not at all improbable that the hemorrhage is part of a collateral inflammatory exudation.

In the pathology of tuberculosis it will be recalled that the tubercle is accompanied by collateral inflammation, exudative in type; and that this exudation may be serous, fibrinous, sanguinous, or purulent in character: Collateral inflammation is a result of toxic action. I believe that this offers the best pathological explanation of this type of hemorrhage.

It is difficult to distinguish this from the type due to an open vessel when the bleeding first appears. It is only after studying the case for a few days that we are justified in arriving at the probable nature of the process. I mention this because the treatment of these two types is very different.

Those hemorrhages belonging to the first, second and third types should be treated by rest. This type seems to do better on stimulating treatment and exercise. It takes a great deal of boldness to go against our traditions in handling hemorrhage. We have been taught to look upon them all as being due to open vessels; but considerable observation and study have led me to a different belief. This opinion is further substantiated by the work of Rosenow and his observations on the streptococcus, and its ability to produce extravasation of blood in the tissues.

I find, in a recent work by W. Neumann[4] that he refers to this same suggestion as having been made by Sahli.[5] This type of hemorrhage rarely proves fatal, but serious damage occurs when it continues for a long time. I am inclined to believe that the harm resulting is due more to the process which causes the hemorrhage than to the hemorrhage itself, yet in one or two cases of this type that I have observed, I felt sure that the prolonged bleeding, lasting over a period of several weeks, had a distinct effect in reducing the vitality of the patient.

Treatment of Hemorrhage.—When we consider the various drugs used in the treatment of hemorrhage, and take into account their supposed action on the pulmonary circulation, we must either conclude that their action is practically *nil* or that nature is able to overcome any harm that might be done by them, for the patient usually survives, no matter what the treatment instituted. This does not mean, however, that the proper handling of the case may not be greatly to the interest of the patient, at times conserving life and often preventing dangerous complications.

In types one and two, unless they prove immediately fatal, the rupture may close with a clot. There is a tendency for hemorrhage to continue until the opening is firmly closed. In the case of hemorrhage resulting from a large vessel across a cavity, bleeding sometimes continues until the cavity is filled with solid clot, and support is given to the clot which closes the vessel wall. In one of my own cases, which came to postmortem, this condition was present. The patient had two large connecting cavities, one below the other. The open vessel was in the upper cavity. The patient bled until both were filled with blood. He was then free from hemorrhage for a period of about three days. Then the clot softened, and began coming away, relieving the protective pressure on the clot in the rupture, and hemorrhage again resulted. This continued until the death of the patient. It is imperative to retain the clot in the opening until it is organized and the vessel is healed. To this end, everything must be done that will quiet the circulatory system. To this purpose mental and physical rest are of most importance. These two measures are of far more value than all the drugs that we have in our armamentarium.

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[4] Zur Behandlung der Hämoptoe, Zeitschrift für Tuberkulose, 1915, Bd. xv, Heft. 1.
[5] Über Tuberkulinbehandlung, Auflage Basle, 1913.

Mental Rest.—Mental rest can be obtained by quieting the patient's fears and giving him confidence and hope. A severe hemorrhage is a frightful thing to see, and the effect upon the patient is oftentimes very alarming. Patients assume different attitudes, according to their nervous stability. Some patients are readily calmed, while others become terror stricken. Fear, when present, should be relieved as much as possible. If it cannot be done by reassurance, some sedative may be resorted to. A hypodermic injection of morphine is probably given more often than any other measure for this purpose. Personally, I do not like to use morphine when I can avoid it, yet it meets three important indications in the treatment of hemorrhage. It quiets the patient; it reduces the tendency to cough and it relieves the nervous shock. Sometimes it seems better to use $\frac{1}{4}$ grain of codeine or $\frac{1}{6}$ grain of heroin in preference to the morphine; but, if the patient is nervous, morphine has the greater sedative effect. I rarely use it in large doses, but usually employ $\frac{1}{16}$ grain hypodermically, and, if necessary, repeat it in one, two or three hours. This small dose of morphine has a sedative effect, and avoids the severe blunting effect on the nerve endings of the respiratory tract, which follows the larger doses, and which often seems to favor pneumonia. I feel that great harm is often done in the treatment of hemorrhage by large repeated doses of morphine. I have seen patients kept in such a state of stupor for several days that they were hardly able to expectorate; and, consequently, did not relieve themselves of the secretions and blood that would have been removed had they been conscious. This stagnation of pulmonary secretions and blood favors pneumonia, and the implantation of tubercle bacilli in the bronchial walls by the bacilli being held in contact with the surface of the bronchi.

Physical Rest.—For the maintenance of physical rest, the patient should be put to bed in a comfortable position, usually on his back with a pillow under his head. If the bleeding is severe, no movement should be permitted. During the first twenty-four hours, as a rule, the patient tires of this position owing to the fact that it calls for the use of muscles that he is not in the habit of using; but at the end of this time he becomes adjusted, and lies with comparative comfort. I usually keep patients quiet for three days after active bleeding ceases. This period represents about the time that is necessary for organization of the clot to occur, and the rupture to close. If the bleeding is severe I even keep the patient quiet until after clots of all kinds have been absent for two or three days. When bleeding has ceased for twenty-four hours, the patient may change his position, with the help of some attendant, but should not be allowed to make any exertion himself. These regulations may seem somewhat stringent, but no precaution should be omitted which will tend to prevent recurrence of bleeding.

Pharmacological Remedies.—Next to physical and mental rest in types one, two and three we may advantageously use remedies which have an influence in lowering blood pressure. While I have not as much confidence in these as I have in physical and mental rest, yet we endeavor to aid in every way that we can and consequently employ them. Any remedy which will quiet down the action of the heart, or any remedy which will produce a lowering of the blood pressure will lessen the pressure in and at the point of rupture. I have quite often illustrated what we desire to do by comparing the circulatory apparatus to a system of hose connected with a central pump, in which the vessels represent the hose and the heart the central pump. In case of a leak in the hose the leakage can be diminished by lessening the force of the pump, or by lessening the pressure in the hose; so it is, at least theoretically, in the case of pulmonary hemorrhage. Remedies which seem to aid in this way are ice over the heart, veratrum viride, aconite, pituitrin, and such vasodilators as the members of the nitrite group,—nitroglycerin, nitrite of amyl and nitrite of soda. The pressure within the system may also be reduced by a reduction in the fluid of the blood. To this end many writers have suggested the use of saline cathartics.

Tincture of veratrum viride may be used by giving five drops every three hours until the pulse slows or nausea appears, then reducing the dose to four or three drops every five hours. The veratrum is somewhat slow in its action; and, in order to get immediate effect, we use nitroglycerin, from $\frac{1}{100}$ to $\frac{1}{50}$ grain, which may be dissolved on the patient's tongue. This method of using nitroglycerin obtains much quicker results than the hypodermic method. The hypodermic tablet should be used, however, instead of the common triturate, because it is more readily dissolved. Nitroglycerin used in this way produces its action within two or three minutes, but its effect is evanescent. Veratrum viride should be given at the same time, and by the time that the effect of the nitroglycerin has passed away, that of the veratrum viride will be evident. Pearls of nitrite of amyl may be inhaled instead of using the nitroglycerin.

Pituitrin is a preparation which has proved quite satisfactory in my hands in the treatment of some cases of hemorrhage. It has been shown to raise the systemic blood pressure and, at the same time, lower that of the pulmonary circulation. We have used it in a number of cases during the past few years and feel that it has considerable value. We usually employ it in ampules of 1 c.c. representing 0.01 gram of dried pituitary gland of the ox in 1 c.c. of sterile normal saline solution and repeat it about every four to six hours.

Increased Coagulability of Blood.—Some writers are of the opinion that coagulation of the blood is delayed in pulmonary tuberculosis; or even, if they do not believe it is delayed, they think if it could be hastened by any line of treatment, that it would aid the control of the hemorrhage. To this end gelatin has been injected subcutaneously, and patients have been fed upon gelatin. The subcutaneous injection of gelatin has at times been found to carry with it tetanus, and it should be prepared most carefully, if it is to be used. It is, however, of doubtful value.

A remedy which has recently been lauded greatly in the treatment of tuberculosis, particularly by the Germans, is a 10 per cent solution of sodium chloride in distilled water. Five cubic centimeters of this is to be given intravenously once or twice a day. Those who have used this line of therapy have reported very favorable results following it. Care must be observed in using it that the needle is in the vein before the solution is injected, otherwise considerable pain will be produced by the salt in the tissues. Great care should be exercised to see that the distilled water is freshly distilled, so as to be free from bacterial contamination. Distilled water, after standing for a few days, may become contaminated with bacteria, and, even though boiled, the danger still remains, not of producing infection, but of producing a protein poisoning. There might be sufficient bacterial protein in the water to produce the symptoms of protein poisoning. The symptoms which usually follow are those of chilliness, fever, cyanosis, vomiting, headache, and pain in the back and limbs lasting over several hours.

I have little faith in the ability of the various preparations used for hastening the clotting of blood, to be able to prevent fatal hemorrhage. I believe very little in their effect and doubt the theory of lessened coagulation being an important factor in keeping up the bleeding.

Circulatory Stimulation.—For the type of hemorrhage which we have described as being congestive or toxic in origin a wholly different line of treatment is indicated. As mentioned above, it is difficult to be sure that the hemorrhage belongs to this type, so it is best to treat the patient with rest for a day or two as though it might belong to the first and second types, before concluding that it belongs to the toxic or congestive type. The toxic type is often prolonged. It sometimes continues for several days, and now and then for many days, small quantities being expelled at numerous times during each day.

These patients seem to do best under conditions which produce circulatory stimulation instead of depression. Strychnine is of value and may be given in doses of $\frac{1}{60}$ grain every three or four hours, and increased to $\frac{1}{30}$. Tincture of digitalis in doses of ten to twenty drops, three or four times a day, is valuable. These are the cases in which adrenin is particularly valuable. Adrenin chloride may be given in doses of from five to ten drops every three or four hours.

Another factor in handling this type of hemorrhage is exercise. It requires bravery to go against all tradition and permit a patient with hemorrhage to move about, but I am positive that I have seen cases of this type improve more quickly after they were permitted to move around than they did by keeping them quiet. My attention was first called to this type of hemorrhage three or four years ago by several cases of blood spitting which continued over a period of many days, although treated by rest and other circulatory sedatives. I added digitalis to this treatment in one such case and noticed improvement. I then finally became convinced that the hemorrhage was of a different type from that caused by an open vessel, and permitted the patients to move about, and was surprised to see the beneficial results follow in the way of cessation of color.

In the paper by Neumann, referred to above, the author takes the same view, and prescribes for this same type of hemorrhage, the same line of treatment which I have followed for the past three or four years.

While I would not advise strenuous exercise, yet movement about the room, and little things that will favor circulatory stimulation may be intelligently tried. Above all things else, the physician should be sure that this is the type of hemorrhage that he is treating before following the line of therapy.

Artificial Pneumothorax.—The discussion of hemorrhage cannot be brought to a close today without considering artificial pneumothorax. Artificial pneumothorax has been greatly praised by many for its effect in stopping severe hemorrhage. Personally, I have had no experience in its use for this purpose; nor have I been impressed with the necessity of using it. My cases, however, are all treated in an institution, where the patients are under constant supervision, and receive the closest attention. This makes considerable difference in the method to be employed. Personally, I do not do much examining in the presence of hemorrhage. I put the patient at rest, assure him, and try to aid nature as best I can. In many instances I have been uncertain from which lung the bleeding was coming. The blood quickly diffuses through the bronchi, passes over the bifurcation; and, not infrequently, finds its way into the opposite lung, as well as the lung from which the bleeding comes. While no harm might come from doing a pneumothorax on the wrong side, yet, if the theory of its action is correct, harm should be expected from such an error. One is not justified in assuming that bleeding is taking place on the side of greatest, or even the most active involvement because both lungs are very frequently involved, and conditions favoring hemorrhage might just as well be on one side as on the other. From my experience I feel sure that most of the cases which are reported as being stopped by pneumothorax would have stopped any way.

I would say that pneumothorax in the relief of hemorrhage, is not indicated in a very large percentage of cases; and, when done, it should be done with caution, lest harm result.

Hemorrhage is rarely a fatal complication of tuberculosis. The fact that hemorrhage stopped after artificial pneumothorax does not mean that it would not have stopped without its employment.

In any line of treatment that is to be used in hemorrhage the physician should bear in mind that hemorrhage nearly always stops of its own accord. Give the patient half a chance, give him rest, confidence, and courage, and, in the majority of cases, little else will be needed.

Diet.—Patients who are suffering from bleeding of the first and second types should be put upon low non-stimulating diet. With those suffering from the third and fourth types this is not essential. The special diet for those of types one and two should consist of milk, eggs, gelatin, toast, and some of the cereals. I usually withhold meat extracts until after the bleeding has ceased. If there is any value in calcium, the use of large quantities of milk in the tuberculosis diet, should have some effect in preventing hemorrhage, because of the calcium in the milk. Its action, however, in this regard, is theoretical. Whether gelatin used by the mouth has the same effect as when used subcutaneously is open to question; but, whether it does or not, it is a food that is refreshing and welcome at this time.

The bowels require attention during hemorrhage. In fact, it is not uncommon to find a decidedly stubborn constipation during and after severe hemorrhage. I have seen several instances where there seemed to be a paralysis of both bowel and bladder, where it was necessary to use the catheter for the bladder, and to remove the fecal masses by mechanical means. It has been our observation that much larger doses of cathartics are necessary during hemorrhage than are commonly required by the same patients ordinarily. Sometimes the use of salines is valuable, either a saturated solution of epsom salts, one teaspoonful every hour until the bowels move; or a tablespoonful of Rochelle salts, repeated if necessary. The compound cathartic pill given at night is also of value; but one of the preparations which has seemed to me to act best in case of hemorrhage is the compound rhubarb pill. We give five grains of this two or three times a day, or, until the result is obtained.

Patients suffering from hemorrhages of types one and two should be compelled to use the bed pan and urinal and not get up for emptying the bowels or bladder; neither should they be permitted to use any strain to force the bowel movement. To avoid strain I often use a compound enema made up of the following:

1 part saturated solution of epsom salts
2 parts glycerin
3 parts water

Tuberculin.—If the patient is undergoing tuberculin treatment at the time of hemorrhage it is best to suspend its use until the hemorrhage is over. In fact, this is a safe rule in all complications. Whenever an acute complication appears in the progress of the case, I make it my rule to suspend tuberculin until this is over, beginning, however, cautiously afterwards. I mean by cautiously, using judgment as to the beginning dose when the remedy is resumed. As a rule, it will not be necessary to omit tuberculin for more than a couple of weeks. The dose used on resumption of the remedy should vary according to the size of the last dose preceding the complication, and the interval between the last dose and the time of its resumption. A further discussion of this will be found in the chapter on tuberculin.

Some writers seem of the opinion that tuberculin favors hemorrhage. That a tuberculin reaction might produce a sufficient stimulation in a tuberculous focus to cause a slight extravasation of blood, is not beyond question. Grant that this is true, it has no harmful results; but that a dose of tuberculin would produce a severe hemorrhage in a patient in whom such a hemorrhage was not going to occur otherwise, remains to be proved. The observation of hemorrhages alike in patients treated with and without tuberculin should show definitely that the relationship between tuberculin and hemorrhage is remote. Most of the observations reported are opinions and not proofs.

Baths.—If the patient is suffering from a severe hemorrhage all baths should be suspended until bleeding has ceased. A tepid bath for cleansing purposes may then be used; but a general bath should be avoided until the danger of bleeding is past. Cold baths should not be resumed until the patient fully recovers.

Complications.—*Pneumonia.*—The most common complications following hemorrhage are pneumonia, an extension of the disease, and miliary tuberculosis. A pneumonic condition is very apt to follow hemorrhages of large size. It usually shows itself by a rise of temperature on the second or third day. The blood trickles down into the adjoining portions of the lung and sets up an irritation, which is followed by symptoms of toxemia. The temperature remains high,—101° to 103°, for two or three days, and then gradually subsides. In severe cases, however, I have seen such a degree of inflammation of the lung follow hemorrhage that a large area of fibrosis resulted, causing practically an obliteration of an entire lobe. When this occurs, the temperature usually subsides gradually, often requiring three or four months to return to normal. Such a case is illustrated in Chapter L, page 542.

Miliary Tuberculosis.—Occasionally, following the opening of a vessel, bacilli pass into the circulation and are scattered throughout the body producing a general miliary tuberculosis. I have seen a number of cases of this kind. The symptoms of the miliary process usually begin to show in about two or three weeks' time. The miliary process may be confined to a portion of the lung, or both lungs, or, it may extend to the other structures of the body, such as the meninges, spleen, liver, etc.

Extension of the Disease.—Miliary tuberculosis being produced in the manner mentioned above, infection may follow the retention of sputum and blood in the bronchi. Many tubercle bacilli are, in this manner, shut up in the bronchi and held in contact with the walls sufficiently long for implantation to occur; so, in this way, bronchogenic infection sometimes follows pulmonary hemorrhage.

Shock.—There is often considerable nerve shock following hemorrhage. I have seen this do considerable harm. In one case in my early experience a patient died following the loss of not more than a tablespoonful of blood. This patient had had an active process. She was in the third stage of the disease, but was getting along fairly well. She had a small hemorrhage, became terribly frightened, and two or three days later passed away. The exact cause of her death was never clear to me. I have always accounted for it, however, by the impression that was made upon the general nervous system, and its resultant shock.

Result of Hemorrhage.—While some observers have stated that pulmonary hemorrhages are beneficial, I do not believe that any good can come from the hemorrhage itself. On the contrary, it is not uncommon for harm to result. Small hemorrhages usually pass over, leaving the patient in practically the same condition as before. Hemorrhages of the second type are very apt to be followed by improvement on the part of the patient due to the changes in the process in the lung which were taking place at the time the hemorrhage occurred; but not as a result of the hemorrhage itself. Hemorrhages belonging to type four nearly always accompany activity; it may be only in a small area, or it may be in a large area. All hemorrhages where a considerable amount of blood is lost, produce a temporary lowering of the resisting power of the patient. The blood, however, is usually soon restored; but, in some instances, a low blood state continues for some time.

CHAPTER XXXIV.

PRINCIPLES UNDERLYING THE THERAPEUTICS OF TUBERCULOSIS.

While remedies of every conceivable nature have been suggested at different times for the treatment of tuberculosis, yet the really important measures have been few. They have been suggested and especially emphasized from time to time by men learned in the profession, and it is around these measures that the history of phthisiotherapy centers. Galen and Celsus, centuries ago, recognized the value of and recommended milk diet, change of climate, particularly dry climate, and sea voyages. Sydenham, in the seventeenth century, emphasized the value of open air and particularly recommended horse-back riding. His teachings made such an impression upon medical men that the idea of "roughing it" is still uppermost in the minds of many members of our profession. The next real advance was made when Brehmer established the institutional care of tuberculosis. He emphasized exercise more than seems best today, yet this was soon modified by his pupil, Dettweiler. With the final proof of the infectious nature of tuberculosis and tuberculin with its specific action given us by Robert Koch, we have another of the important principles in tuberculosis therapy. The construction of a carefully balanced therapy, however, has been the part of many men, some famous, others whose names are little known.

Interest Awakens Slowly.—The popularization of the treatment of tuberculosis makes headway very slowly, some reasons for which I shall endeavor to point out later.

The systematic treatment of the tuberculous patient can scarcely be said to have received serious consideration until the last quarter of a century; and even during this period it has received far less than its importance demands. The attitude of both laymen and physicians toward this great problem is one of unquestionable disinterestedness. This statement will hold despite the organizations which are doing their utmost to create interest, regardless of the fact that many dispensaries and sanatoria have been established throughout the land, in spite of the many publications that have been made and public addresses that have been delivered, and in spite of the fact that millions of dollars are spent annually for the cause. Tuberculosis is a general widespread disease, affecting all members of society, carrying a death toll of one in every ten or twelve of the population; destroying one of every three who die between the ages of fifteen and thirty-five; and yet it is impossible to secure a general and lasting interest in the disease which alone is capable of producing satisfactory results either in the way of prevention or cure.

Cause of Apathy.—There are many reasons for this apathy. The·fact that tuberculosis has existed back as far as records go, and has been fatal during all that period; the fact that most of the cases which come to the notice of either medical men or laymen today, die; the fact that the disease is such by nature that it is usually advanced before it is suspected; and the fact that most medical men wholly fail to understand its peculiar pathology and clinical course, and are unable to successfully treat it, all operates against the popularization of its successful treatment.

I can see no hope for the general early diagnosis and cure of the tuberculous patient unless diagnostic measures are found which can be applied by the medical profession as a whole or at least in a large part; neither can I see any chance for the general application of curative measures unless forms of treatment can be found which can be applied by the rank and file of the profession. It is not sufficient that specialists are able to diagnose the disease early and treat it successfully. It is human nature to speculate now and then about the unknown and to wonder about the things that we are unable to accomplish; but it is not human nature for men generally to take a vital interest in things beyond them, things which they are sure they cannot accomplish. The early diagnosis of tuberculosis is difficult. The guiding of a patient through the disease to a successful issue requires a knowledge of tuberculosis, and of the patient, and an ability to preserve the confidence of the patient over a prolonged period of time until healing has occurred. Many may have the knowledge, but fail in maintaining their own interest or that of the patient until a cure has been obtained.

Many men can practice surgery and find it inviting. The same may be said of internal medicine, of affections of the eyes, the nose and throat, the ear, and, in fact, most branches of medicine. Few men, however, find the long, drawn-out treatment of tuberculosis either interesting or inviting; consequently the disease suffers at the hands of our profession and does not receive the same attention that other maladies do. It is much more difficult to hold one's interest and the interest of the patient over a period of from six months to one or two years as is necessary in tuberculosis, than it is in such diseases as pneumonia, typhoid or the surgical affections which last from one to three or four weeks. This fact operates against the proper study of tuberculosis and prevents the tuberculous patient from receiving the benefits which science can give him.

Curability Must Be Judged by the Work of the Most Competent.—In judging of the curability of tuberculosis then, we must be guided by the best that can be done by the leaders; by the men who are endowed by nature and training to cope with this disease. The history of tuberculosis therapy, unlike that of medicine as a whole, or surgery, or even most specialties, is written in the biographies of comparatively few men, and these, for the most part, have lived during the past three or four decades.

Rational Therapy Based on Pathology and Life History of the Disease.—There can be no rational therapy for tuberculosis except it be based on the pathology and the peculiar life history of the disease. There can be no adequate therapy without early diagnosis. With reference to the infection and its relation to acute clinical tuberculosis, the writer, while discussing the relationship of early pathological changes to the symptoms and physical signs,[1] recently said:

"Probably no one factor would have greater influence on the early diagnosis of tuberculosis than an accurate conception of the early pathological changes which take place and their relationship to the clinical symptoms and physical signs which result. This is especially important because it will demonstrate that infection occurs long before clinical evidence and that the early symptoms are not at all in keeping with the seriousness which a pulmonary infection threatens. In diseased conditions we must not think of the symptoms and signs as entities, but we must picture in our minds the process which lies back of and produces them.

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[1] Southwest Journal of Medicine and Surgery, November, 1915.

"At the beginning of this discussion I want to make it clear that pulmonary tuberculosis as we find it, affecting the apex of the lung, is believed by the best students of the subject to be not a primary infection, but a metastatic infection, coming from a focus which may be far distant in other parts of the body. This primary infection is commonly found in the peribronchial glands, but may be in other glands such as the cervical and mesenteric.

"The metastatic infection, such as that in the lungs, takes place after a certain amount of immunity has been developed in the organism, consequently the bacilli are deposited in cells which have been endowed with a certain degree of specific defensive power. This, of itself, has a tendency to prevent implantation and to check the growth of the bacilli when implantation has occurred, thus causing the infection to be circumscribed and mild. The bacilli which form the metastasis, having circulated in the blood prior to implantation, are apt to be of low virulence because, escaping into the blood stream, they are diluted so that very few are deposited in the tissues at any one place and these only after having circulated with the blood and having been reduced in virulence by the action of the antibacillary elements found therein.

"For these reasons, the primary metastasis in the lung is, as a rule, of the fibroid or non-virulent type. The bacilli, being of low virulence, and the tissue cells being endowed with specific defensive powers, they do not multiply rapidly, causing necrosis and extensive collateral inflammation with secondary metastatic foci; but, instead of destroying the cells, they irritate and stimulate them to the formation of new cells. For this reason the primary metastasis in the lung is usually fibroid in character with a tendency to encapsulation rather than dissemination.

"It has been shown by pathologists that the lungs of more than half of adults contain tuberculous foci, but that a very large per cent of these have healed without producing recognized clinical symptoms. The bacilli in quite a large proportion of these pulmonary lesions, however, after lying quiescent for a time, varying from a few months to many years, become active, multiply, and show a tendency to dissemination. As yet we cannot offer any satisfactory reason for this renewed activity in these foci.

"Coincident with the activity in the process, which means multiplication of the bacilli, we have a diffusion of toxins into adjacent tissues, resulting in their injury. Necrosis and caseation of tubercles occur and the bacilli escape into adjacent tissues, there to form new metastases.

"The bacilli which form these new metastases gain access to the new tissues either through the lymph spaces or through the air passages. Lymphatic infection is especially favored by the low resistance of the tissues which results from the action of the toxins upon them. As a result of the toxic action, an exudation occurs which is accompanied by a stagnation of lymph. This, then, affords us the picture of the early pathological changes in tuberculosis which are associated with the extension of the primary metastases,—infiltration of the tissues with secondary metastatic tubercles which are surrounded by exudative inflammation. It is at this time, coincident with the appearance of collateral inflammation and the secondary metastases that clinical symptoms and physical signs show themselves."

The importance of these early changes in their relationship to a rational and successful treatment is evident and shall be emphasized later.

Small Lesions Most Curable.—Modern phthisiotherapy owes its development primarily to the observation of healed pathological lesions. While this had been observed by pathologists before, it took the genius and imagination of Brehmer to make the correct clinical application of the pathological facts. Brehmer was impressed with the fact that it was the small tuberculous lesions which healed, and that therapeutic measures should be employed while the lesion was small. He developed and followed the principle in his therapy that if one could find out the things which favor the development of tuberculosis, and find measures to overcome them, these same measures would act in producing healing when the disease was already present.

This was practically the announcement of the principles of the present day widely-employed "hygienic-dietetic" treatment of tuberculosis. While it has been changed and modified and made to include other measures, yet the essential truth of Brehmer's idea was that of building up the resisting power of the patient in every possible way.

Man can live with a small tuberculous lesion without noticeable physical harm resulting. The truth of this statement is borne out by the fact that infections are so common where health seems to be unimpaired. If harm is done we have no way of detecting it. The seriousness of these small lesions lies more in the fact that unless healed they are foci of danger from which injurious toxins are given out and from which metastatic foci are scattered to new tissues.

These pathological facts are well illustrated by many postmortem records; but perhaps by none better than the carefully analyzed records of Hart.[2] Hart had previously reported on 400 carefully made autopsies, in which he had examined the apices of the lungs in a most painstaking way for evidence of tuberculous infection. Since these patients came from the northern section of Berlin, where the conditions of life are most unfavorable, he extended his investigations to West Berlin, where conditions were more favorable, in order to see if the same percentage of apical infections would hold. The result was that apical tuberculosis was found in 64.3 per cent of the former series and 45 per cent of the latter. It must be borne in mind that this includes only such metastatic infections as occur about the apices of the lung. Glandular infections are omitted from consideration. These statistics compare favorably with the carefully made postmortems of Naegli where 71.43 per cent were found to show apical infection. Naegli's observations were made on patients dying in the almshouse; from which we assume that they, for the most part, had lived under bad conditions.

Spontaneous Healing of Small Lesions Offers Hope.—Further analysis of Hart's 400 cases shows that one-half of those having infected apices (32 per cent of the whole) were latent or healed and about the same number (31.4 per cent) were still active. Roughly speaking, one-third (36.6 per cent) were free from apical infection; one-third (32 per cent) had quiescent and healed lesions; and one-third (31.4 per cent) had active tuberculosis. These statistics may show a slightly larger per cent of infections than would hold for the population at large; nevertheless, we are probably fully justified in assuming that more than 50 per cent of all adults have apical tuberculosis, and that there is a time in all of these when the infection is active. Since about 10 per cent of the race dies of tuberculosis this leaves a large margin to recover. This number is even much larger than is apparent because it is not from one-ninth to one-sixth of adults who die of tuberculosis but one-ninth to one-sixth of the entire population.

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[2] Medizinische Klinik, 1913, Nr. 50.

The number of cases which heal of their own accord is therefore very large; and this carries with it great hope for the successful treatment of the disease in general. It is pertinent to inquire carefully into these spontaneous cures for therein may be found the principles which will underly a rational and successful therapy. The most striking fact, which presents on careful examination, is that the healed lesions are, for the most part, small. While every now and then we find a widespread lesion which has developed and healed without its presence having been suspected; yet this is not the rule. Widespread lesions, for the most part heal only after the institution of most careful measures for aiding the patient.

Many of these small metastatic foci in the lung produce no recognizable symptoms. Neither the patient nor those who associate with him are cognizant of the presence of the infection. Many others produce at times sufficient disturbance to attract the attention of the patient and impress upon him that something is wrong. The toxic symptoms such as malaise and lack of endurance normally predominate in such lesions; and cause the patient to take a rest, a change of work, a tonic or some measure which will increase his resisting power. This, of itself, is often followed by the desired result, and all symptoms disappear, sometimes temporarily, again permanently.

Here we have given us in our study of spontaneous cures, two very important principles in healing.

1. Small lesions heal most often (not infrequently without their presence being suspected).

2. In lesions which produce slight symptoms, measures which lessen the demands upon the patient, likewise those which directly improve his condition, even though simple and carried out only over a brief period, are often sufficient to cause healing. Such cures usually occur without the diagnosis of tuberculosis having been made. It is only in studying the history in connection with a later diagnosis made during life, or postmortem, that the true significance of these former indefinite symptoms can be understood.

Evidences of Healing of Clinical Tuberculosis.—We have thus far only considered pathological cures; but our evidence of the curability of tuberculosis is also drawn from clinical observation. While these small lesions are found with great frequency at the postmortem table, their presence having been unsuspected during life; clinically, we find symptoms of varying degrees of severity, and lesions both circumscribed and extensive, which result in a disappearance of all symptoms and a conversion of the active inflammation into scar. The relative frequency with which this occurs depends not so much upon the unaided resources of the individual as it does upon the intelligent measures which are brought to his assistance. While small circumscribed lesions heal spontaneously far oftener than they spread, the reverse is true when extension has occurred and clinical symptoms have appeared. Then, unless some form of definite aid is instituted whereby the defensive forces of the individual are conserved and directed advantageously in his behalf, cure is the exception.

Thanks to modern investigators, rational therapy comes in at this point and makes healing again the rule, and failure the exception, providing the extension is not too great before the curative measures are applied.

Spontaneous Healing Versus Active Treatment.—The opinion as to when spontaneous healing may be depended upon, on the one hand, and when active curative measures must be instituted in order to save life, on the other, is not unanimous. A paradox here presents itself. Specialists in tuberculosis, the class above all others which believes firmly in the curability of the disease, are almost unanimous in the opinion that when the lesion has become so active or so extensive as to cause clinical symptoms, help must be brought to the aid of the patient if cure is to be expected. Of the contrary opinion are a great many medical men; men, who, for the most part, are not convinced that tuberculosis is curable. They fail to see the necessity for instituting so rigid and so time-consuming a regime when the symptoms are so slight as they are at the beginning of activity and metastatic extension. In support of their opinion they point to the fact that a tonic, forced feeding, or some other simple measure, is often promptly followed by a gain in weight and a cessation of symptoms. They fail to recognize that the early symptoms of activity are usually slight and temporary in character. The after-history of most patients will show that such apparent restoration to normal may occur once or twice, or several times; but, in a majority of instances, is followed later by an advanced disease and the death of the patient. This later observation causes this class of observers to lose confidence in the curability of the disease. The important lesson, however, is that it is this early clinical tuberculosis which is curable, and that the *cessation of symptoms is not synonymous with healing. Healing is a slowgoing pathological change requiring months for its completion, even after all symptoms have disappeared.*

Gradual Development of Specific Cellular Defense.—The time has now come for us to inquire more particularly into the principles which underly the cure or healing of tuberculous lesions. How is spontaneous cure brought about and what can be done to aid this process and make cure more universal, or to bring about a cure when the natural forces of the body have failed?

We must admit at the outset that we cannot offer a direct and satisfactory answer to these questions; yet, by discussing them in general terms we believe we can arrive sufficiently near the truth to show at least the general qualifications which healing measures must possess in order to be of value.

This part of our theme can be evolved best by going back to the child and following the course of inoculation, infection, metastatic infection, and healing.

With our knowledge today, we assume that the child is born free from tuberculous infection; but, that inoculations of bacilli begin soon after birth and continue during the life of the individual; and that these inoculations result in infection in the great majority of human beings who reach mature age.

Tuberculosis is a specific disease, and its cure consists in the establishing of immunity. The term immunity, as used in this connection, requires explanation. It should not be understood as absolute, but only as a relative immunity; in other words, a specific defense against the tubercle bacillus whereby the tissue cells are able to withstand inoculations of greater numbers and more virulent bacilli. In this respect tuberculosis differs from such acute infections as smallpox, typhoid fever, scarlet fever, and whooping cough. One attack of these diseases so changes the body cells that they are almost wholly immune from further infections during the remainder of life. This is not true of tuberculosis. There is probably rarely, if ever, obtained an immunity so absolute as to protect its possessor against further inoculations of tubercle bacilli, providing the dose be sufficiently large and the strain of bacilli be sufficiently virulent.

This difference is partly due to the nature of tuberculosis. Most of the infectious diseases with which we are acquainted are acute in character. While many bacteria inhabit the upper air passages and the gastro-intestinal tract; yet, they are here in a saprophytic state and are, for the most part, harmless. As far as known, we are not at liberty to assume that the causative agent of the diseases above mentioned, as well as many others which might be mentioned, are inhabitants of the human organism, except during the time when they are epidemic. Tuberculosis, on the other hand, like syphilis and leprosy, is a chronic infection. When inoculation has occurred, the causative agents entrench themselves in the tissues, surround themselves with conditions which are favorable to life; and sometimes favorable to their multiplication. If they are not able, at the time of inoculation, to multiply and produce clinical manifestations of their respective diseases, unless destroyed by the organism, they hide themselves away for the time; and, later, if the opportunity offers, escape from their entrechments and renew the attack. When a tuberculous infection has once occurred the patient is liable to suffer from metastatic foci at any time until healing has taken place. The recognition of this particular characteristic of tuberculosis is extremely important. That such secondary metastases do not occur regularly is due to the fact that the tissues throw a protective wall about the bacilli which is often sufficient to encapsulate them and hold them as prisoners; and, in case of escape, to the fact that the natural and acquired specific defensive powers of the tissues destroy the bacilli before implantation takes place.

While the child is born free from infection, it is also born with only such specific defense as is handed down from parent to offspring because of previous racial contact with the disease. It must develop its immunity after coming in contact with specific microorganisms. This does not mean that the child is born helpless. From fighting infections throughout generations a certain amount of inherited specific defense is handed down from parent to offspring. While we have no way of measuring the efficacy of this, yet our clinical observations prove its truth. The lack of resisting power shown by such primitive peoples as the American Indians, the native Africans, and the Icelanders against tuberculosis when first exposed to it, as compared with the resistance of the European who has been exposed to it for generations, bears evidence of this fact. Aside from this inherited specific defense, the child is endowed with a very active lymphatic system which is capable of destroying bacteria. During the early years of the child the mucous membranes are easily penetrated by bacteria, but the lymph spaces are relatively large and the lymphatic tissue is relatively active. Dangerous infections do not occur at this time nearly so often as might be expected from the apparent helplessness of the child. I doubt whether this lymphatic defense receives credit in proportion to the service rendered during our apparently helpless baby days.

The first battle against the tubercle bacillus is fought in the lymphatic structures. In the little child, we do not find tuberculous foci at the point where the bacilli enter the tissues. The mucous membranes of the mouth, the nose, and the alimentary canal are affected so rarely that such primary lesions in the child are pathological curiosities. While tonsils and adenoids contain bacilli caught in passage, yet a tuberculous infiltration or ulceration of these tissues in the little child, before infection has occurred elsewhere in the body, is practically unknown.

The same is true of the lymphoid structures in the intestines. Such lesions occur rarely except when opportunity for continuous surface contact offers and rarely, if ever, as primary inoculations. Prior to the time that infection has resulted, or, at least, prior to the time that the inoculations of bacilli have resulted in changing the childish tissues and endowing them with specific defensive powers against themselves, bacilli pass through the mucous membranes without hindrance; and, unless previously destroyed, are carried at once to the regional lymphatic glands, there to be subjected to the action of the protective lympatic elements; to be destroyed if possible; if not, to be withheld for the time being from further invasion of the tissues.

For a local implantation to occur in the mucous membranes or other tissues through which the bacilli pass, a certain amount of hindrance to their passage must be interposed, such as is offered by the specific tissue reaction which takes place between bacilli or bacillary products and the cells which are endowed with specific protective properties as a result of previous inoculations.

After inoculation has occurred, while the battle is being fought for mastery between the invading bacilli and the invaded tissue cells, the bodies of bacilli are being destroyed with the liberation of their specific products which must be taken care of and rendered harmless or else the organism will suffer harm. The human organism is so constituted that it is able to adapt itself to many inimical environments and protect, or, at least, partially protect, itself against foreign toxic substances. This it does through its tissue cells. They are endowed with the power of producing defensive substances when stimulated by any foreign toxic product. So, in tuberculosis, the liberation of the products of the bacillus calls upon the body cells for the protection of the organism against them. The result is that the cells are changed in such a way that, thereafter, they are endowed with the power of producing specific substances against the bacillus and its toxins. In this way the destruction of bacilli results in specific cellular defense of the body against tuberculosis. This defensive power varies from one scarcely recognizable to one so great that it will protect the organism against myriads of bacilli as is evident in advanced tuberculosis, where healing often occurs in spite of the fact that millions of bacilli coming from the ulcerative surfaces in the lung pass over the mucous membranes of the bronchi, trachea, throat and mouth, as well as the digestive tube, after being swallowed.

When bacillary substances or products elaborated from them, circulating with the body fluids, come in contact with the cells in and near tuberculous foci, a reaction occurs which results in stimulation and accompanying hyperemia. This favors the production of new tissue cells, and the encapsulation of tuberculous foci. This becomes a very important factor in the healing of tuberculosis as is shown in the chapter dealing with specific medication.

We can now clearly see that the first principle underlying the cure, hence the treatment of tuberculosis, is *the development within the organism of a specific defensive power on the part of the body cells whereby they become antagonistic to and are able to destroy tubercle bacilli;* and that this specific defense manifests itself by a reaction between the body cells and any bacilli or bacillary products which invade the tissues; and further, that when the reaction occurs in the tissues in and surrounding the tubercle, it is accompanied by conditions which favor the production of new tissue and scar. *Thus, specific cellular reaction prevents the ready spread of infection and favors healing of existent foci.*

If this specific cellular defense could, either naturally or through artificial means, be kept so strong as to prevent further metastases from forming, or, if sufficient focal stimulation could be produced to insure encapsulation and fibrosis, our problem in the treatment of tuberculosis would be comparatively an easy one; but such is not the case. There is a tendency for the bacilli to scatter and every now and then they succeed in doing so. The truth of this statement is clearly evident if we but realize that no one dies from the original tuberculous focus, but only as a result of metastases which are able to form in new tissue because of the invading bacilli being able to break through whatever encapsulating wall may have been formed and overcome whatever specific defensive power the tissues may have been able to develop.

We are led to believe that after a time the body cells lose their specific protective powers to such a degree that metastases are formed with greater ease. This may be judged from what may be almost regularly observed in those who are physically strong, in their reaction toward tuberculosis,—the tissues react strongly to the cutaneous and intracutaneous tuberculin tests during that time when a small tuberculous lesion is active, but react slightly, or not at all, to the same tests in those who have been free from symptoms for a term of years. It is further supported by observing the clinical course of tuberculosis. The inoculation occurs in the child and remains confined to the lymphatic glands in most instances for a number of years. Later, however, it breaks forth from the walls which have confined it and becomes implanted in new tissue, there to start a new process. Theoretically we might assume that when the period between the encapsulation of the early focus and the spreading of the infection is a long one, conditions have been favorable for a reduction in specific defense, because the specific stimulant has been wanting.

The earlier the inoculation, the more serious the resulting infection; the greater the danger of general dissemination and the less the chances for healing. The probable reason for this is that when inoculations are withstood for a considerable time, the cells gain an ever increasing power to develop specific protective defense as a result of the stimulation received from the specific toxins set free by the destruction of bacilli in the tissues. With the increasing age of the child, specific defense increases as may be inferred from the fact that infections are more circumscribed, and show a tendency to become chronic. That age alone is not the determining factor may be inferred from the manner in which primitive races succumb to infections when meeting them for the first time. They show the same, or even greater, lack of specific defense when brought in contact with tuberculosis for the first time, than the newborn civilized child, and suffer from the same acute types of the disease when infection occurs.

Decrease in General Resistance Cause of Clinical Disease.—During the decade from fifteen to twenty-five, pulmonary tuberculosis begins to assume prominence. The non-pulmonary forms become less common. With each succeeding decade the nature of the disease becomes more and more chronic. The decade following puberty is apparently a period of low resistance. Tuberculosis does not heal so readily at this period as it does immediately prior, or later. This is the time when much of the metastatic infection of the lung tissue is occurring. It probably represents a time when the specific defensive power of the body cells, which was developed during the earlier years of life, has diminished and also a period when the natural resisting power of the individual is low. The period of life from fifteen to thirty-five years is the period of greatest mortality from tuberculosis. This is the time in life when the greatest physical and mental strains are being endured; such as, those incident to entering upon the period of manhood and womanhood, those of an occupational and social nature, and the cares incident to married life and business ventures.

It would seem then, that many of the metastases which occur during this trying period of life, whether they come from the primary glandular focus, or from without, come at a time when both specific and natural resistance are lowered.

That lowering of natural resistance is a factor in tuberculosis, morbidity, and mortality, is evident from the study of statistics. Infection, clinical disease and the percentage of deaths is in direct proportions to the economical and social status of the people.

Improvement in Natural Resistance Proves Important Therapeutic Principle.—The influence of physical strength and nervous stability upon tuberculosis can also be seen by approaching the subject from the standpoint of healing, as previously discussed. When spontaneous healing has failed to take place, and the disease has progressed, we must admit that the spreading of infection was due to a lack of specific resisting power on the part of the invaded organism, due either to the absence of specific bacillary substances which are necessary to produce specific defense, or to a failure of the body cells to respond to the stimulation when furnished. That the resisting power of the patient is an important factor in these cases of early clinical manifestations is proved daily in our practice. When the clinical disease is young, meaning by this when the earliest clinical symptoms manifest themselves, it takes very little in many instances to raise the battling forces of the patient to such a degree that the activity ceases and the infection becomes quiescent. It should be added in passing, however, that this is not true after the disease has become more extensive and more active. In these early cases, where spontaneous healing fails, the least little thing that adds to the general improvement of the condition of the patient, providing that it is sufficient to raise the balance of resistance in his favor, will suffice to check the progress of the infection. Later, however, as the disease becomes more widespread, it is only by the employment of an extremely comprehensive and helpful regime over a long period of time that the spread of the disease may be checked and the acutely inflamed areas may be replaced by scar. *When the disease has once reached the stage that the effect of its presence is manifested in disturbed function on the part of the various organs and tissues of the body and particularly if this disturbance is marked; in other words, when symptoms and particularly marked symptoms have occurred, healing in any considerable proportion of cases requires that the natural forces of the patient be carefully conserved.* Such measures as rest from work, long hours of sleep, open air life, a sufficient diet, care of the appetite and digestion and general attention to the mental condition of the patient are utilized to advantage and are necessary to the end desired.

This second principle underlying the therapy of tuberculosis, is based upon the facts just mentioned and may be stated thus: *All measures which help to improve the general condition of the patient make the body cells functionate better, and increase the natural defense of the body; and, at the same time, they enable the body cells to react better in the production of acquired specific defense when stimulated by the bacillary toxins,* thus aiding in bringing about healing.

Requirements of Meritorious Therapeutic Measures.—Every meritorious measure commonly employed in the therapy of tuberculosis depends for its action upon the fact that it either produces a specific stimulation of the body cells which results in an increased specific defense against the tubercle bacillus; brings about conditions about the process of infection, which favor the formation of scar; or so improves the functionating capacity of the body cells that they are able to improve their natural defense of the body and at the same time are better able to respond to the stimulation of specific bacillary products which come either from the bacilli in the foci of infection or are introduced artificially from without.

With this conception one can readily see that nearly every measure that has been suggested in the therapeutics of tuberculosis acts indirectly, if at all. We depend, not upon a direct attack against the bacillus, but upon a strengthening of the body defenses so that it may be better able to repel the offensive of the bacilli.

The various bacillary substances (tuberculins) used therapeutically, while not perfect in their stimulation of the body cells to the production of specific antibacillary substances, yet owe their usefulness to their ability to produce protective substances against the particular bacillary substances contained in themselves and to their ability to stimulate focal reactions. This makes it essential then, that the particular vaccine (tuberculin) used should contain as many of the different bacillary products as possible.

Measures which produce hyperemia of the tuberculous foci owe their action to the fact that they are able to better apply the antibacillary elements of the tissues whether natural to the host, or produced as a result of stimulation from bacillary substances found in the foci within, or introduced artificially from without.

Practically all other useful therapeutic measures act by improving the functional capacity either of some particular group of body cells or of the body cells as a whole. This action may be either of a direct nature, such as would result from such measures as open air, good food, and tonics, or indirectly such as those which relieve harmful symptoms and complications.

One can readily see why so many different remedies and measures having such widely different modes of action have been suggested as having therapeutic value in tuberculosis. All such measures, if valuable, act by improving the functionating capacity of some organ or organs, or by raising the resisting capacity of the body cells as a whole. *If the action of any given measure is sufficient to cause an improvement which is capable of helping to turn the fighting balance in favor of the patient, it* *has value.* Oftentimes very little is needed to do this; more often, however, a great deal is required. The mistake has been made by men suggesting new, helpful measures, that they considered them as "cures" for tuberculosis. This applies to the author of the suggestion of the use of dog fat, the same as the one who suggests the removal of the colon. All such suggestions as "cures" show a total lack of comprehension of the disease, tuberculosis, and the process which attends its healing. These measures may be of value. One may aid in one case, others in another; yet they are not "cures" and should not be so called.

Neither must fresh air, good food, and general hygienic measures be considered as "cures." They are only aids in that they raise the resisting power of the patient. These are of greatest use because they are more general and surer in their action; but their action is no more specific than any other measure which improves the functionating capacity of body cells.

Those particularly interested in tuberculosis are periodically called upon to express their opinion on the supposed value of some remedy or measure which is credited with having special action in this disease. Their answer can be based upon the simple questions:

1. Will it stimulate the body cells to produce specific antibacillary substances?
2. Will it aid in the more direct application of the antibacillary elements to the focus of disease?
3. Will it stimulate the cells in and near the focus of infection to the production of new tissue cells and thus hasten fibrosis?
4. Will it affect the condition of the body cells in such manner as to improve the functional activity of any particular important group or of the body as a whole?
5. Will it improve the activity of the cells so that they will react stronger in the formation of specific bacillary substances when stimulated by bacillary substances?

If it will meet any of these requirements it may be of some value as a therapeutic measure. In describing therapeutic measures to be employed in the treatment of tuberculosis, one would hardly be expected, however, to do more than consider the more important ones, such as hygienic living, the proper mental attitude, open air, properly regulated rest and exercise, food suited to the needs of the patient, as well as the disease, hydrotherapeutic measures, the use of light, particularly sunlight, and the various medicinal remedies that may have a tonic effect. These shall have proper consideration in separate chapters.

There are many remedies belonging to Class 4, which act indirectly, among which are those for the relief of various symptoms such as remedies for cough, measures for the promotion of sleep, proper handling of complications upon the part of the digestive system, and adequate care of the heart. While these measures do not act by directly improving the body cells, they do act by relieving some distressing complication or by improving the action of some important organ of the body,—thus relieving the organism of the conditions which interfere with proper cellular activity.

Definiteness in Therapy Necessary to Success.—Of the many measures which are able to aid in building up the natural resistance in tuberculosis, open air, food, rest, and exercise are probably used most generally. Unfortunately these are often employed without any comprehension of their action. It has been so generally published during our campaign against tuberculosis, by men who are supposed to know, that the only cure for tuberculosis is open air, milk and eggs, and either rest or exercise, usually the former, that either no impression or often a wrong impression is created in the minds of those who prescribe as well as those who attempt to apply these measures. When specialists, writing on the treatment of so serious a disease as tuberculosis, employ such indefiniteness in discussing therapeutic measures, it detracts from their efficacy.

Many a tuberculous patient has endeavored to breathe, eat and rest or exercise himself into a cure with no other guidance than the instructions given by a well-meaning physician, following the teachings of the profuse writings on hygienic therapy, "to live in the open air, eat lots of food and either rest or exercise," according to which of these measures was insisted on strongest by the particular leader followed. This, however, is not treating tuberculosis. This is evidence of a misunderstanding of principles, a misapplication of measures, and an absolute disregard for that *careful technic which is essential to success, and which cannot be disregarded in the application of medical measures any more than it can in surgical.* The measure itself may give some aid to the patient when employed in a lax way, but might be able to turn the balance of resistance in his favor if employed correctly. Every one of these supposedly simple measures is pregnant with harm as well as help. It is their intelligent application that is demanded in tuberculosis, their application to the particular needs of each patient; therefore *the most important factor in the cure of tuberculosis is intelligent guidance—the man who treats the case.*

Importance of Proper Mental Attitude.—One of the most valuable remedies falling under Group 4 is psychotherapy. This measure should be divested of all that is opprobrious; for it is capable of being of as great value as any other one measure employed in therapy. There is just as much need of relieving the nervous and psychical systems of overstrain and training them to respond normally to adequate stimuli as there is to relieve and train the physical.

This is especially necessary when we understand the vicious circle which is maintained through the nervous system in tuberculosis. Many people suffer from depressed nervous organisms prior to the time that they develop tuberculosis. But those who do not, through the action of specific toxins, soon find an irritable condition of nerve cells and, as a result, an instability of nerve action. The threshold of nerve response is lowered so that impulses are discharged through the nerve filaments by a reduced stimulus. The patient suffers from malaise, his endurance lessens, his strength fails, he becomes irritable, the stability of his nerve cells is destroyed, and a general inefficiency of action is noted in all of the important functions of the body—the patient is neurasthenic. This nervous condition is distinctly irritative in character. The patient becomes fearful, discouraged about himself, and pessimistic. These depressive states again send stimuli through the vegetative nervous system which, through their action upon the sympathetics cause a general derangement of function; and through stimulation of the adrenals cause undue amounts of adrenin to be secreted (Cannon), to continue the same cycle of depressed function.

The proper instruction of the patient, so that he may know the cause of his depression; and the corresponding cooperation on his part often relieves it in a great part; or, at least, relieves that part which depends upon himself. Fear is displaced by hope, discouragement by courage, and pessimism by optimism. The nerve cells become less irritable, the threshold of response is raised and the psychical equilibrium of the patient improves with a resultant increased efficiency in the activity of important viscera and a corresponding improvement in the general conditions of the patient.

Positive, optimistic mental therapeutics should take its place along with fresh air, proper food, and regulated rest and exercise, as measures for building up the resistance of the patient. Psychotherapy is of greater value in such a chronic toxic disease as tuberculosis than in more acute ailments.

Method of Employing Remedy More Important Than Measure Itself.—It has long been known that *the more optimistic and enthusiastic the physician who treats chronic diseases, the better the results.* The explanation is clear and has a physiological basis. He inspires his patients to a more exact cooperation, he inspires them with hope and courage and thus relieves the cells in the central nervous system of needless and harmful irritation, and lifts from them the inhibiting action of the depressive emotions as expressed through the vegetative nervous system, thus causing improved function on the part of the vital organs of the body, with a resultant general improvement in physical and nerve tone.

Well-meaning men, of unquestioned ability, prescribe open air, an abundance of nourishing food, and regulated rest and exercise, and still get poor results in tuberculosis by counteracting their effects through a doubtful pessimistic attitude.

There is much foolish discussion as to the relative merits of certain measures of therapy. In this regard it should be understood that there is no definite, specific merit in any single measure used; nothing like the action of antitoxin in diphtheria. The merit of each is relative and depends upon two variables, the patient and the physician. One physician may obtain such good results with open air life and good food that he thinks it useless to employ other measures; another thinks open air of comparatively little value, but prefers forced feeding and perhaps some particular bath; a third finds the ordinary hygienic measures greatly aided by induced pneumothorax; another relies on open air and some favorite tonic, while still another supports hygienic measures by tuberculin. All may obtain a measure of good results, or all may fail, according to the judgment exercised in their application. There are so many tonic, upbuilding, measures in the list that any combination of them may be valuable and sufficient to improve the general resisting power of a large proportion of patients and raise their fighting strength to such a state that the organism may overcome the disease. So one combination acts best in the hands of one man, another in that of others.

If the subject of therapy is approached in this manner it shows that it is not so much the measure, but the manner of its application that cures. Technic is the important factor after all.

CHAPTER XXXV.

RELATIONSHIP BETWEEN PHYSICIAN AND PATIENT.

The Prevailing Attitude of the Medical Profession Toward Tuberculosis.—The subject of this chapter calls attention more particularly to a discussion of the relationship between the individual patient and his physician, but I desire to include also a discussion of the general attitude of the medical profession toward the disease, tuberculosis.

There is a tendency, though in all probability, not intentional, for the medical profession as a whole, to deal unfairly with the disease, tuberculosis. While this disease has called forth a coöperation on the part of many special students, societies of hygiene, special societies for its study and prevention, municipal and governmental commissions, yet the profession, as a whole, has neglected to study it with the seriousness which it deserves.

Tuberculosis is a study which belongs to general medicine, but the general apathy of the profession toward it has made it necessary that it be taken up and made the province of specialists. How long it will be until it will be returned again to internal medicine cannot be told; but, that it will eventually be as much a part of general medicine as syphilis, typhoid, pneumonia, and the diseases of metabolism, can well be anticipated.

The progress which has been made during recent years in its study from the laboratory as well as the clinical side, has been made possible largely through the close application of men who are devoting their entire energy to this one disease; but, as their knowledge becomes a part of general medicine, the necessity of the specialist will gradually disappear and the tuberculous patient will be able to obtain adequate care and treatment at the hands of medical men generally.

The apathy on the part of the general medical profession toward tuberculosis is due to the hopelessness which has surrounded it through all past generations and a lack of confidence upon the part of the profession as a whole to either diagnose or treat it satisfactorily. Tuberculosis is a disease that offers the greatest hope of cure. In order to attain this end, however, the profession must understand its nature. The members of the profession never stop to question whether they can diagnose and treat typhoid, pneumonia, scarlet fever, and other common afflictions. They must assume the same attitude of confidence toward tuberculosis.

Every physician is interested in syphilis because it can be diagnosed within a reasonable degree of accuracy, by the Wassermann reaction; and because each one feels that he can obtain favorable results by the application of salvarsan or mercury. While tuberculosis is equally as curable a disease as syphilis, yet the members of the medical profession do not seem to have confidence in their ability to treat it. The interest of the profession in cancer is far greater than in tuberculosis; not that cancer is more curable, but, because a much larger number of the profession have confidence in their ability to operate and remove cancer. If tuberculosis is to secure an interest from the profession equal to that of syphilis or cancer, it must come through the profession in general realizing that this is a disease that they can diagnose and treat successfully.

With increased knowledge and the newer methods of diagnosis, greater accuracy is attained; and, with the improved facilities for training medical students today, physicians are graduated with an ability in diagnosis that did not belong to us who graduated a decade or more ago. If medical men in general but learn that the disease can be diagnosed early and have confidence that they can make the diagnosis; and that they can treat it successfully; and that the application of therapeutic measures is within their power, the result will be that a greater proportion of the profession will gain confidence in their ability to successfully cope with this disease.

The entire difficulty of therapy would be solved could we but find a specific remedy. Today every measure applied in the treatment of tuberculosis is indirect. It is only he who has sufficient patience and perseverance to bring to the patient the benefit which can accrue from many different tonic measures, and who is able to secure a cooperation on the part of the patient for a sufficient length of time for his resisting power to overcome the infection, that can regularly hope for satisfactory results.

Prior to the time when the hopefulness of this disease will become thoroughly impressed upon the profession, and prior to the time when early diagnosis and successful therapy will become a part of general medicine, the most that can be hoped for is that the profession will recognize the best that is being done by those who are working most earnestly and most successfully for the relief of those afflicted with this disease. If they will but assume an attitude of hopefulness, an attitude of interest and confidence, and realize that this disease can be cured by others if it cannot be cured by themselves, that will be the first step toward making the therapy of tuberculosis general. The attitude of indifference must be displaced by an attitude of interest.

The attitude of the general profession may be judged by the programs of medical societies throughout the country; and, by observing the attitude of the profession toward the papers read. In the first place, many programs can be found which give little or no space to the subject of tuberculosis. Others are found where papers are read, but received with indifference and a general lack of enthusiasm. To be sure, part of this is due to the fact that nothing new is being offered. So many papers discuss nothing except what the general profession knows. If, however, the newer work could be brought before the medical men, I am sure greater interest could be awakened. It would be well for those who are interested in this subject to see that at least one paper of merit is given at every general medical meeting, in which the new and practical advances are brought out.

Candor Between Physician and Patient.—The treatment of tuberculosis resolves itself into the relationship between an individual physician and an individual patient. Tuberculosis is a chronic disease. He who would treat it should first acquaint himself with the life history of the disease. It is necessary for him to understand that the disease starts in childhood; that it may cause clinical symptoms now and then which often go unrecognized, and that it often does not break out until later in life; but, when it does, it may come on gradually, or it may light up suddenly. If this early history is understood, the importance of treating the disease early will be more thoroughly appreciated. Not only does tuberculosis come on slowly, but it heals slowly, consequently the relationship which exists between the man who has the disease, and the physician who guides him through it, must be one that extends over a prolonged period of time. In the early cases it will be, at least, several months; and, in the more advanced, it will be many months and often years. It is evident to anyone undertaking to guide the patient through a disease of such a character as this that there must be unusual candor and trust between the patient and the physician.

The success or failure in obtaining the patient's confidence often depends upon the first visit. It should be assumed that when the patient consults a physician he comes to learn the truth. It is due the patient from the physician that he make a diagnosis, be able to give him a prognosis, and outline a rational line of therapy which, if followed out, will give him his best chance of cure. On the other hand, the patient consulting the physician should be in a frame of mind to receive the truth and obey instructions and carry out his part of the therapeutic plan. Unfortunately, this degree of candor and confidence is not general. The relationship between the physician and the patient often begins as one of deception—the patient and friends furnishing misleading information, and the physician either failing to find the nature of the trouble, or misinforming the patient of his findings.

The physician who attempts to treat tuberculosis should be thoroughly imbued with the spirit of modern phthisiotherapy. He should know that tuberculosis is a preventable disease, a communicable disease, and a curable disease. He should also know that the earlier the disease is detected the less danger there is of its being communicated to others, providing the patient is properly instructed and is willing to take adequate precautions. He should also understand that the earlier the disease is detected the greater the opportunity for its cure, providing proper remedial measures are instituted and the patient is willing to do his part.

The part of the patient is no less than that of the physician. While the physician must give instructions, the ultimate progress of the disease will depend much upon the attitude of the patient. There are many instances in which this disease is discovered so late that cure is impossible, no matter how conscientiously the physician and patient cooperate, and no matter if the line of therapy advanced is the one most suited to the individual case. On the other hand, such a conscientious cooperation on the part of the physician and patient will bring many doubtful cases to a successful issue, and will give the best opportunity of cure under all circumstances.

Whether or not the cooperation of the patient is to be secured depends almost wholly upon the physician. It is necessary for the physician to acquaint the patient with both the hopeful and hopeless side of tuberculosis. He should be told that when the disease is discovered early and treated in an intelligent manner the great percentage of patients can recover. He should also know that when the disease is discovered later, or discovered early and allowed to run on, there is still hope of securing an arrestment, although the fight will be much harder. It is not tuberculosis, but neglected tuberculosis that kills. While mild infection offers hope to the majority of patients, severe infection is just as sure death to as large a number.

Not only does the curability of tuberculosis depend upon the ability of the physician to recognize the disease early, but upon his ability to properly manage it. The disease may be curable, the patient may be thoroughly willing to cooperate, but the physician, through lack of knowledge, or through lack of interest, may be unable to obtain the result that should be had; so, not only candor, but intelligent guidance should be instituted at an early date if a favorable result is to be obtained.

Upon the candor of the physician depends not only the patient's recovery, but also the lives and health of those with whom he associates. It is wrong to submit the friends of patients, particularly children, to the danger of contagion in order to supposedly spare the feelings of the individual.

I have never yet seen a patient who was seriously injured by telling him, in a proper and humane way, that he had tuberculosis. I have seen patients greatly perturbed; but, it is a principle in psychology that the human mind will become accustomed to almost any fact after dwelling upon it for a few days. Some psychologist has said that the mind can accustom itself to, and accept the most serious fact, after about three days' time. Conveying to a patient the fact that he, or she, has tuberculosis, does not bear with it the idea of hopelessness; consequently, the fact should not be withheld on the ground of supposed injury to the feelings of the patient.

The high death rate which exists today from tuberculosis, is not in keeping with our knowledge of the nature of this disease. If we would but be frank with our patients, and remove the danger of infection from the little children, we could probably reduce infections and cut our death rate in two in a comparatively short time.

When tuberculosis was considered to be an incurable disease, and believed to be transmitted by inheritance, instead of infection, there was not supposed to be the urgent demand for candor that there is today. At that time, telling a patient that he had tuberculosis was the same as pronouncing a death sentence upon him, for he knew that his days were positively numbered. Today conditions are changed. The patient can be told that he has tuberculosis; and, at the same time, be told that it is one of the most curable of all chronic diseases; and, furthermore, in order to afford him the best chance of cure, and in order to prevent his immediate friends from becoming infected, he must know the nature of his infection.

Deceptive expressions, such as were formerly used universally in apprising patients of the fact that they had tuberculosis, and which are even used today all too commonly, should not be employed in dealing with this disease. It is wholly wrong to deceive the patient by telling him that he is "threatened with tuberculosis," that he has "weak lungs," "a sore spot on the lung," "throat trouble," "bronchial trouble," "bronchitis," "asthma," "liver trouble," "stomach trouble," "stomach cough," and "malaria," when the real cause of the trouble is tuberculosis. These expressions may quiet the patient's fears, but that is not what is desired. It is essential that he should know that these expressions mean tuberculosis. Such deception carries with it unnecessary death and would not be tolerated in dealing with other serious diseases in medicine.

Treating this subject elsewhere,[1] the writer stated:

"Imagine a physician telling his patient with appendicitis that he has 'cramps' or 'colic!' Imagine what his surgeon friends would say! Yet many of these same surgeons who would condemn their brother physicians for calling appendicitis 'cramps,' are informing their tuberculous patients that they have 'weak lungs,' 'throat trouble,' and other equally deceptive conditions. It is not sparing the patient to withhold from him the diagnosis of early tuberculosis and allow him to progress to a hopeless condition. The physician, therefore, should insist on telling his patient the nature of his trouble, and the patient should demand the truth from the physician."

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[1] Pulmonary Tuberculosis, William Wood & Company, New York, 1908.

Not infrequently the physician suspects tuberculosis, but fears his ability to make the diagnosis, consequently, hesitates to tell the patient lest he be in error. All medical men have not the requisite training, nor the practical experience to enable them to make a physical examination and be able to definitely settle to their own satisfaction that tuberculosis is present during its early clinical stage. They should, however, by taking time, and looking into the clinical history of the patient, and securing aid from without, if necessary, be able in nearly all instances to confirm or disprove their suspicions. To this end they must not forget the value of the tuberculin tests, as mentioned elsewhere in these pages, Vol. I, Chapter XVIII. If the disease is sufficiently advanced for expectoration to be present, no matter how slight its amount, it should be collected, not for one day, but for two or three days and be examined for tubercle bacilli or lymphocytes. If doubt should still exist the patient can either be observed longer, being carefully instructed in the methods which would have a tendency to build up his resisting power; but, what is still better, a physical examination of the chest should be made by one who is an expert in doing so, or an expert x-ray examination should be made of the chest, the former being given the preference in every instance. It is in these early cases that the best interest of the patient demands a diagnosis; and, if the attending physician cannot establish it, he should call a consultant, the same as is done in other diseases where doubt exists.

If the diagnosis is made there are no grounds for secrecy or deception. The patient's interests, as well as those of his associates, demand that the truth be known.

How to Inform a Patient That He Has Tuberculosis.—The feelings of the patient should always be spared as much as possible. As a rule, he suspects the nature of his trouble. Oftentimes the relatives and friends underrate the intelligence of the patient to such a degree that they bring the patient to the physician and ask him to make a thorough examination of the chest, at the same time, requesting him not to tell the patient if anything is found. Such a course should not be followed; and, if it is, it defeats the purpose, for it either reassures the patient that nothing is the matter or leaves increased suspicion in his mind. He believes that nothing was found or he would have been informed.

If the patient has not suspected the presence of tuberculosis prior to examination he will doubtless be somewhat surprised when told of its presence, and may be depressed when the facts are laid before him, although the amount of depression may be greatly mitigated by the manner in which he is apprised of the fact. If he has already suspected it, which is nearly always the case, he is, as a rule, relieved by knowing the truth, for, rightly, or wrongly, people place great confidence in their physician and when they know that he knows what is the matter they feel that the way is open to recovery; but, if they feel that he is uncertain or in ignorance, they rightly feel that they have no grounds for placing confidence.

When I make a diagnosis of tuberculosis I invariably tell my patient. There have only been one or two exceptions to this rule during the last ten years of my practice. I have had anxious parents, and brothers and sisters implore me not to do so, telling me of the dire consequences upon the health and happiness of the patient which would result from such knowledge; but in spite of such insistence on the part of friends, I have often told the patient and had him laugh at their lack of confidence in his ability to accept the truth.

The most difficult position in which I have been placed in this regard has been when the physician, calling me in consultation, has requested me not to say anything to the patient about his trouble. This puts the consultant in a false light and takes away from the patient a great portion of the good that could come from such consultation. It prevents the consultant from dealing fairly and honestly with the patient and giving him the courage that his wide experience would bring.

Owing to medical ethics, a consultant is not free to talk to another physician's patient and is bound to either respect the request, convince him of his error, or reject the consultation. I have, in a few instances, refused to examine patients under these conditions. No physician has a right to make such a demand upon a consultant. It is doing double harm to the patient; for it deprives him of the aid that should come from the consultant's experience, and at times the silence brings with it an increased assurance that nothing is the matter. If consultations in medicine are ever to be of value to the patient there must be a free discussion and the consultant must be given the liberty to give the patient the benefit of his knowledge and skill. The consultant, on the other hand, must be absolutely frank and conscientious in his dealings with his brother physician in order to make such a relationship possible.

There are many ways in which a patient may be told that he has tuberculosis. Very often, where the patient comes to me saying that he wants me to tell him if he has tuberculosis—if my examination reveals its presence, I say to him: "I find evidence of infection." I then ask him whether he knows anything about the nature of tuberculosis. He usually replies that he knows very little, whereupon I explain to him its nature, telling him of its frequency in childhood, how it extends later to the lungs in probably one-half of all adults; that some of these heal while others produce active symptoms; that when active symptoms are first produced the disease is usually early; and that by finding out its presence and adopting the proper measures for relief, an arrestment may be secured in a very large percentage of such cases. It is not well to dilate too much upon the danger of the advanced disease in these early cases. At times, however, I tell patients, who make statements that they never saw patients get well, that all advanced cases were one time early like theirs and in a curable stage but, through negligence, they were allowed to become hopeless. In other cases, where the patient is not supposed to know that the disease is present, after making an examination, I often ask the question: "Did you ever suspect that there might be something wrong with your lung?" The answer will nearly always be "Yes." In this way you can make the patient answer your question and tell himself that he has the disease. I have found this one of the easiest ways of giving the information. After this I usually dilate upon the character of the disease, as mentioned above. If the patient has an advanced lesion when consulting you for the first time it is not well to expostulate upon the seriousness of advanced tuberculosis, unless it be essential to do so in order to secure his cooperation in the proper treatment. It is well to tell him that early tuberculosis is a curable disease, but that considerable time and cooperation is necessary to bring about a cure. Advanced tuberculosis is less curable, but even patients suffering from the advanced forms may secure an arrestment. Some of them may lose their symptoms wholly. In others, certain symptoms such as cough and expectoration may persist, although the patient may be restored to a physical condition which is not inconsistent with the enjoyment of life and the carrying on of general pursuits.

It is best to talk in general terms, rather than to direct one's remarks to the specific individual under consideration. At first thought this may be considered deception but, in reality, it is not deception. It is impossible to tell what patient will get along well and what one will fail to improve on seeing the patient once; and, yet, it is at this first visit that the patient should be informed of his trouble.

Cooperation of Patient and Physician.—The cooperation of the patient is essential in treating such chronic affections as syphilis, nervous diseases, diseases of metabolism and tuberculosis. One of the great factors in producing a successful result in chronic curable diseases is the physician's ability to keep up his interest in the patient, and to keep up the patient's interest in himself so that he will cooperate long enough to attain the desired result. Aside from the pathological changes present, the greatest factor operating against obtaining a favorable result in tuberculosis is the fact that the patient feels well although he is suffering from a serious and dangerous disease. This is difficult for the layman to understand. He is free from clinical symptoms long before he has a pathological healing. If he were to take his own feelings as a guide he would give up the treatment long before it is safe for him to do so. He must depend wholly upon the word of his physician and the physician must seek and jealously maintain the confidence of the patient. In order to secure cooperation the patient must be made to understand the character of the disease that he is fighting, so that he will know why it is necessary for him to closely follow a definite program, foregoing seemingly harmless pleasures and avoiding the activities of the business and social world. He will then understand why he must keep his defensive powers active, so as not to permit the bacilli to obtain the upper hand. It is all but impossible to secure this necessary cooperation unless the patient knows why it is required. It is an insult to his intelligence to ask him to rest, remain out of doors, give up business and follow such instructions as are usually given in the treatment of tuberculosis, when he has no definite idea of why he is doing it. How often do we hear patients say: "Had I known I had tuberculosis I would have done differently. I would have avoided doing many harmful things which I did and would have done many helpful things which I omitted doing."

Tuberculosis improves slowly. The pathological changes necessary to the restoration to health, such as occur in a few days or a few weeks in acute infections, require not only a few months, but even years, in tuberculosis. The patient should know this, and the physician has no right to expect cooperation during all this period if he minimizes the disease by calling it such things as "throat trouble" and "bronchitis."

There are many exacerbations which come on during the course of the disease which must be explained. During the long course of tuberculosis, after it has reached the active stage, there are periods of increased activity every now and then. The disease in certain portions of the lungs becomes more acute; the tubercles soften and rupture. These changes are accompanied by certain symptoms. Sometimes the most prominent symptoms are on the part of the gastrointestinal tract; at other times cough and expectoration are increased; again, fever with general symptoms of toxemia is predominant. Physicians often attempt to satisfy their patients by calling these attacks by such terms as "stomach disturbance," "la grippe," or "bronchitis." In doing so they admit that they are poor physicians, not to be able to cure such simple troubles. It is no wonder that patients who are held in such ignorance, become discouraged and usually drift to other physicians; or, if their confidence is sufficient in their attendant, give up the fight and go on to death. Physicians who treat their patients in such a manner as this cannot help having little faith in the curability of tuberculosis. They neither do themselves justice, nor give their patients a chance to get well. Such a policy is not calculated to inspire confidence sufficient to tide over the many crises which occur; and to keep the patient buoyed up until a final result has been obtained. Keeping the patient in ignorance also fails to secure the necessary cooperation in carrying out the hygienic regime which is necessary to prevent spreading of infection. When the physician tells the patient that he has tuberculosis, and that, unless he uses extreme care, he may infect his children and other dear ones, he will usually, particularly if the patient belongs to the intelligent class, be met with a willingness to carry out such care in personal hygiene as is necessary to make himself harmless. Those who are so selfish as not to be willing to take such precautions, should be forcibly compelled to do so by law.

If a relationship of candor and confidence between physician and patient is entered into at the beginning of treatment, confidence will continue to grow as the patient's improvement follows. His increased faith in his physician's knowledge, as proved by the course of the disease as time goes on, will help him through many trials and discouragements which are bound to beset the path of all who are attempting to throw off a chronic tuberculous infection.

Tuberculosis, as I have stated elsewhere, is a many sided disease. It affects all of the leading systems of the body—the respiratory, circulatory, digestive, and nervous. If the physician bears this fact in mind he will be able to explain the various symptoms which manifest themselves on the part of each system, upon a physiological basis; and, while the explanation does not relieve the symptoms, it satisfies the patient and secures greater cooperation.

In order to merit the cooperation of the patient, it is needless to say that the physician should possess a comprehensive understanding of the disease. He should no less have a comprehensive understanding of his patient. There is no particular psychology of the tuberculous patient which does not hold with other people; but there are certain definite psychological states present during this disease which should be recognized, because they will greatly aid in securing a whole-hearted cooperation.

From what I have written thus far it can be readily understood that cooperation depends upon intelligence. A great deal of the disagreement and confusion which arises in discussing the subject of tuberculosis comes from one man observing intelligent patients, who will cooperate, while another's experience is gained among the ignorant, who will not cooperate. A certain amount of intelligence is essential to obtaining an arrestment in tuberculosis. It cannot be taken from this statement that people who are considered intelligent in ordinary things, will always make the best patients.

My observation has been that patients may be divided into several classes, as far as their chances of getting well are concerned. Those belonging to the most favorable class are the patients who take an intelligent view of the disease, and who are willing to submit to regulation and endure what deprivations are necessary in order to get well. This class is made up largely of the middle class, economically. It is very difficult to secure intelligent cooperation from the wealthy or from the extremely poor, particularly the ignorant poor. A man may be intelligent from the general standpoint, but he may use very poor judgment in his cooperation for cure.

No two physicians can deal with their patients exactly alike, yet each one may obtain satisfactory results. It is necessary for a man to deal according to his own individuality, consequently, there is no place for dogmatism in outlining rules for caring for the patient, any more than in conducting a case at law.

I obtain the best results by making my patients intelligent upon the subject of tuberculosis. I endeavor to explain to them the nature of the disease, something of its course, the difficulties in the way of cure, complications that may arise, aids to cure, and their own part in bringing it about; always impressing upon them that the final result depends very largely upon themselves. I always make it a point to prepare the patient suffering with activity, for ups and downs, which are bound to come in the course of his disease. If he has not yet reached the temperature stage, while the findings in his lung indicate that it is coming, I tell him that he will probably have fever before he is through, but that he must have the right idea, and know that these stages of activity are a part of the general process,—that they will come no matter what line of treatment he follows. I also tell him that he will feel badly during these times, but that they are only incidents in the course of a long drawn out disease. I often use the following illustration by way of clarifying this point. The course of tuberculosis is much like a long automobile ride. Every now and then rough places may be found in the road; in fact, the roughest places may as well be just before the destination has been reached, as at any other part of the journey. These rough places do not indicate that we are not progressing favorably in our course. They are only a part of it, and are as essential to the journey as the smoother stretches. Fortunately, while the rough places make the journey unpleasant, they do not prevent reaching the destination.

In sanatoria, patients may be talked to *en masse*. Lectures may be given now and then advantageously. The same thing may be done in clinics. Pratt's class work is a splendid method of instructing the tuberculous. It has always been my custom in giving talks to patients upon problems connected with the subject of tuberculosis, to omit such things as may have a purely discouraging and depressing aspect. I try to give them optimistic ideas rather than doubts. An improved mental attitude is nearly always noticed following such talks. The spirit of cooperation is increased, and the patients become more tractable. Instruction of this kind is most applicable to the intelligent class of patients. With those who are less intelligent, different methods must be instituted. I have never liked the idea of governing patients by threats. It has always seemed to me that the relationship between physician and patient should be one of mutual interest and sympathy, and that the patient should not be handled by compulsion. To be sure, compulsion will be necessary now and then with individuals of a certain type, but I believe it is a mistake to attempt to handle the great mass of tuberculous patients in this manner. By far the greater portion of patients are tractable, it is only a few who are vicious. The dog responds to kindness, and it is rare that a human being becomes so low that kindness will not have some influence upon him. It is well always to bear in mind that the tuberculous patient is a thinking, hoping human being, not a machine or dumb animal.

A class of patients which is very difficult to handle is composed of those who have preconceived notions, who are thoroughly satisfied with their own knowledge and ability, and who yield slowly to the ideas of others. Patience and tact will usually manage this class by displacing wrong ideas by right ones. I make it a rule never to ask my patients to do anything for which I cannot give a reason. If the reason is plausible, it helps to secure cooperation.

Treating tuberculosis calls for close attention to detail, and the most careful individualization, if the best results are to be obtained. The fact that tuberculous patients are necessarily under treatment for a long time brings about a different relationship between physician and patient from that which exists in acute diseases. No man who has the spirit of humanity in him can see the struggles that these patients are making day after day, week after week, month after month, and at times year after year, watch their efforts at cooperation, and know the way in which they are depriving themselves of the enjoyments to which they are accustomed, without becoming warmly attached to them. During all this period, too, the patient looks to the physician for guidance in every important particular. This brings an added sense of closeness, and it also adds to the responsibility. The physician is the guiding hand. He becomes the father confessor to the patient, as well as his physician.

I do not believe that it is possible for a physician to produce as good results in the treatment of tuberculosis by holding himself aloof from patients and treating them coldly, as by entering into their lives, taking an active interest in their welfare, and showing them that he is a human being, endowed with attributes of kindness and sympathy. Such a physician commands confidence on the part of his patient, not only because the patient thinks it offers him the best chance of cure, but also because his personality demands it. These attributes were exemplified most perfectly in Trudeau, whose humanity and sympathetic kindness proved an inspiration to countless numbers, who were struggling for the mastery of this disease.

Tuberculous Patients Need Close Medical Guidance.—It has been so long said that there is no cure for tuberculosis that a misconception has gone abroad that the tuberculous patient does not need medical guidance. Nothing could be farther from the truth. There is no one thing that will cure tuberculosis; yet, if the disease is rightly handled at the right time, the patient may recover health in a large per cent of cases. That no one thing will cure tuberculosis, all must recognize; and, until some specific method of cure has been obtained, we must work indirectly. The fact that we must work indirectly calls all the more for close guidance. The indirect methods which we use are simply those of aiding nature in her struggle against the disease. Had we a specific remedy such as quinine in malaria, antitoxin in diphtheria, salvarsan and mercury in syphilis, our attention to the general condition of the patient would be less essential; but, inasmuch as we haven't such remedies at our command, we must depend on nature to bring about a cure. It is the duty of the physician to study the physiology of the various important systems of the body and to improve their action wherever such can be done. Any general aid to the digestive, circulatory, or nervous system, will improve metabolic activity; the cells will functionate better; and, in so doing, the patient's resisting powers will be enhanced.

It requires greater intelligence, however, to comprehend these principles and to apply the indefinite number of measures that are necessary to bring about this desired result than it does to inject salvarsan or mercury in syphilis, or to administer quinine in malaria or antitoxin in diphtheria. The patient must not be expected to have the knowledge necessary to apply measures of this kind. If he will give his cooperation, that is all that can be asked, and this must not be expected unless the physician merits it through his greater knowledge of the principles of physiology involved. *A layman's knowledge would warrant him in using such remedies as mercury and quinine, or even salvarsan and antitoxin with greater hope of success than the application of the indefinite measures which are employed in the treatment of tuberculosis, which act by increasing the resisting power of the patient and not by attacking the bacillus directly.*

Early infections yield quite readily to treatment, but, neglected, pass on to a serious stage. Late infections have such a complex pathology that arrestment is extremely difficult. It is wholly wrong for the physician, upon diagnosing tuberculosis, to tell patients that nothing can be done for them; that they must cure themselves; and turn them away without telling them how to cure themselves. This attitude is wrong to the patient and does an injustice to the medical profession. If the physician, with his superior knowledge of the physiological activities and pathological embarrassments of the body, feels his own inability to bring about a cure, or to help the patient to an arrestment, how can he expect the patient to be able to do this?

Medical men would deserve little credit if, on making a diagnosis of typhoid or pneumonia, or any other serious disease, they should say "I can do nothing for you. You will have to go to bed and use your own judgment;" yet the chances of recovery in tuberculosis, by the indefinite methods so often applied, gives them no better opportunity than such a course would if the patient was suffering from these other diseases. It is the duty of the profession to help the tuberculous.

There is a difference of opinion on the part of various clinicians as to the necessity of frequent conferences between the tuberculous patient and the physician. My experience leads me to believe that the closer the association the better the results obtained. I have heard physicians say that the tuberculous patient needs nothing but occasional examinations and advice. To my way of thinking, such an attitude is pernicious. It is responsible for the ultimate death of many patients. I have great faith in tuberculous patients when they have an intelligent understanding of their disease and show a willingness to cooperate; but, my faith is much greater if I can watch them carefully, and can keep encouraging them and urging them to do the things which are favorable or not to do those unfavorable. Even the most conscientious will fall short of their intentions and disappoint not only themselves, but their physician, unless they are carefully directed and restrained by frequent conferences. Then, aside from the part which the patient plays, there are changes which are constantly going on in tuberculosis, little things which are coming up to worry the patient—disturbances on the part of the various organs which will have a tendency to lower his resisting power. These should be corrected at the time, rather than be allowed to continue.

I have heard physicians say they do not know what to do or say to their patients if they see them frequently. Frequent visits require an intimate knowledge of this many sided disease, a keen interest in the patient and a willingness to go into minute details of the patient's life.

It has been my custom for many years to treat all patients, whether they are pay patients or charity patients, in the same manner. I see them frequently and show my interest by giving them the time that is necessary for a conference; and I expect them to show their interest by cooperating and doing their part in carrying out instructions. The virtue in many so-called tuberculosis cures which require frequent visits of the patient to the physician, lies in the close association, as much as in the remedy itself. This is not saying that the remedy does not have some value, but it emphasizes the fact that the close personal relationship is one fact which keeps the patient encouraged and gives the remedy a better opportunity for acting under the best circumstances.

There are many doubts and fears which enter into the mind of the tuberculous patient and it is necessary to have someone with whom to consult. There must be someone to whom he can go and take his cares, whether they are small or great, real or imaginary, and in whom he knows he will find a ready and sympathetic adviser. If he does not have a physician to whom he may take these matters he will tell his troubles to the neighbors and the result is misdirection and meddlesome advice. How often a word of explanation of a supposed serious symptom has quieted the patient's anxiety and given him better digestion, better sleep, and more complete rest for the day. The beneficial effect of this cannot be doubted. I have often seen fear and discouragement, as well as the effect of painful symptoms, disappear by simply explaining to the patient that there was nothing seriously wrong. The effect of suggestion is marvelous. It is as legitimate in treatment as open air or food. It brings to the patient improved cell activity and keeps him happy and contented. An intelligent explanation is far superior to drugs in the relief of many symptoms.

It is necessary that the patient have full confidence in his physician. If he does not, he does both himself and his physician an injustice to continue under his care. If my patients do not have full confidence in me I want them to change their medical adviser; for, without such confidence, the cooperation necessary to obtain the best results cannot be had. It is far worse to have a patient lack confidence than to have him go to a colleague.

It requires determination and character, as well as money, to get well of tuberculosis. This is a long drawn out disease that taxes the efforts of the patient to the utmost; and he who carries the treatment to a successful issue is truly a hero. A contented and happy disposition is a valuable characteristic for a patient to possess, while a discontented pessimistic disposition will often deprive its owner of excellent chances of cure.

Candid understanding, mutual confidence, sympathetic interest, thorough cooperation, and well directed intelligence on the part of the patient and physician will help to make many of the problems relative to the treatment of tuberculosis much simpler, and the results of treatment much better.

CHAPTER XXXVI.

OPEN AIR.

During recent years open air and tuberculosis have become almost as inseparable as the names of the Siamese Twins. Open air is generally spoken of as a "cure" for tuberculosis. That the facts do not warrant such confidence should be thoroughly understood. Open air is only one of many measures for increasing the functional capacity of the body cells; and, to the extent to which it is able to do this does it aid the human body in overcoming tuberculous infection. It has no direct action upon the tubercle bacillus. It must be classed along with good food, light, proper regulation of the patient's rest and exercise, properly directed psychotherapy, and other measures which have a beneficial influence upon the body cells. The only reasons that it has been looked upon as a cure is because of its universality, its ease of application, and its general action. Its action is not limited to any particular organ, or any particular group of cells, but is exerted upon all the functions of the body, the same as psychotherapy; but psychotherapy cannot be used as successfuily by men in general as the treatment of patients by open air. While of all the factors which operate in the aid of the patient to overcome tuberculosis, fresh air must be given the first place, yet it must be understood that it has no specific effect upon the disease process. Unless this is understood, too much reliance will be placed upon it; and other measures which may be of great value to the patient, and which if utilized might insure his recovery, will be withheld from him. Open air alone may help a certain per cent of patients to overcome their disease; yet there are many others who will require the assistance of other tonic measures in order to be able to gain mastery; so it is very important that the exact part played by open air in the cure of tuberculosis be generally understood. Where it alone will not cure, it may do so, if assisted by other helpful measures such as suitable diet, proper guidance, the institution of psychotherapeutic measures, or the improvement of some particular organ that may be working against the individual.

Regardless of the limitations of open air treatment, it marks one of the greatest advances in the therapeutics of tuberculosis. It seems strange in this day of sanitation to think that the use of such a simple measure as open air in the treatment of tuberculosis has been employed for less than three-quarters of a century; and to think that it has been employed extensively less than a quarter of a century.

Owing to the peculiar pathological changes in tuberculosis, when patients are left to themselves they are apt to think that they suffer from frequent colds. These colds are nothing other than acute inflammatory processes in the tuberculous tissue; but, since they come, in certain stages of the disease, more or less frequently, the patient is inclined to believe that they are a result of exposure, and, consequently, learns to fear draughts and open air, and such other things as he feels bring them on. So, naturally, prior to the time of the teachings of sanitarians, the tuberculous patient shut himself up in order to avoid these supposed sudden colds.

George Bodington, an inhabitant of Sutton Coldfield, Warwickshire, England, was probably the first man to combat these established ideas by the establishment of a fresh air institution. He employed open air and wrote regarding his method in 1840, two decades prior to the time of Brehmer. He said: "Cold is never too intense for a consumptive patient; the apartment should be kept well aired, so that it should resemble the pure air of the outside, pure air being used in the treatment as much as possible." This statement startled not only laymen but medical men as well; and, like all revolutionary ideas, reacted upon its originator. Bodington was maligned, and spoken of as being insane, and, so bitter was the persecution on the part of the medical profession that patients were afraid to stay in his institution. His experiment did not last long and the open air idea made no further particular progress until Brehmer started the first permanent sanatorium nearly twenty years later.

It would seem that so simple a thing as fresh air would appeal to everyone; but not so. Even in spite of the world-wide campaign for fresh air in the homes, schoolhouses, and workshops, it still meets opposition on every hand. The medical profession, as a whole, is away behind its leaders in the use of it and carries out the principles with great timidity.

It is not always easy to live in the open air. In cold rigorous climates the question of securing sufficient fresh air in the house is very difficult of solution. Fresh air is looked upon by many, who prefer comfort to hygiene, as being unnecessary, and a scientific process of freezing. The action of fresh air is as marked upon the non-tuberculous as upon the tuberculous. When patients are taken from closed rooms and put in the open air, whether it be the child at school, the worker in the shop, or the inmate of the home, the effect is usually prompt and the change is evident in a general improvement in metabolism. The patient's appetite increases; his digestion becomes better; the desire for sleep is increased; sleep proves to be more refreshing; and the nervous tone of the entire organism is improved. The picture is that of general improvement in all of the body functions. Open air does not furnish an equal stimulus for all patients suffering from tuberculosis. In those who have previously lived in close rooms and who have been deprived of fresh air to the greatest extent, the effect is usually most marked. On the other hand, when those people who are accustomed to live in the open air, develop tuberculosis, this measure must be supplemented by others in order to produce an adequate defense. Here, a beneficial result cannot be obtained by open air alone, because the disease has developed in spite of it. He already has fresh air; and, if he is to have a stimulation of his vital forces, approaching that which fresh air supplies to the one who is not accustomed to having it, it must be obtained by the application of other tonic measures. Open air is not a cure for his tuberculosis, but an aid to his vital forces; and should be supported by other measures that will help.

Upon What Does the Effect of Open Air Depend?—It has long been taken for granted that the sole remedial factor in open air is oxygen and that the principal deleterious factor to be avoided in closed rooms is carbon dioxide; but recent study shows that this is not true. There is probably as much oxygen in the stalest confined air as the individual can use; and there is nearly always an amount of carbon dioxide below the quantity necessary to cause injury. The belief in the oxygen has been so strong that we have been taught that oxygen in the form of ozone is particularly valuable in the treatment of tuberculosis; but it now seems positive that the beneficial action of open air in improving the general body tone is entirely apart from the oxygen or CO_2 content.

Important contributions have recently been made to this subject by several groups of workers. Those by the New York State Commission on Ventilation[1]; F. S. Lee,[2] one of the members of the Commission; F. A. R. Russell;[3] and Professor Leonard Hill,[4] will give the reader an excellent idea of the newer knowledge on this subject. These workers have made most careful studies to determine the beneficial and detrimental influences of air, and bring forth proof of the fact that the value of open air depends largely on its temperature, humidity, and movement; and their effect in relieving "heat stagnation in the body and monotonous conditions of cutaneous excitation."

The fallacy of the theory that the evil effects of air depend upon the impoverishment of oxygen is shown by the fact that oxygen in the most crowded room is never diminished by more than one per cent, yet patients will live and be comfortable when the oxygen is reduced ten per cent or more.

The effect of the excess of carbon dioxide in the air has also been assumed, but not proved. Even in rooms where the air would be considered unusually stale, there may not be an increase of more than one-half of one per cent; and, furthermore, it has been shown that when there is an excess it cannot enter the body. When the amount of carbon dioxide in the air increases, pulmonary ventilation also increases,—the patient breathes more rapidly and more deeply,—but there is no marked effect shown upon the individual while in an atmosphere in which the percentage of carbon dioxide is increased greatly. Such an increase as is found in ordinary rooms would exert no appreciable influence upon the human organism.

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[1] American Journal of Public Health, 1915, vol. lxxxv.

[2] Recent Progress in Our Knowledge of the Physiological Action of Atmospheric Conditions, Science, Aug. 11, 1916.

[3] The Atmosphere in Relation to Human Life and Health, Smithsonian Miscellaneous Collections, 1896, vol. xxxix, No. 1072.

[4] Report on Ventilation and the Effect of Open Air and Wind on the Respiratory Metabolism. Reports of the Local Government Board on Public Health and Medical Subjects, New Series, No. 100, 1914.

The question of expired air containing organic poison has also been investigated by various observers and it seems that it can be dismissed as unsubstantiated. The physical effects of air, however, are extremely important. While the chemical effects and deleterious effects of confined air, from the standpoint of its chemical constituents, seems to be disproved, the physical effects are assuming more importance. The physical effects of air depend upon the degree of temperature, its water content, and the degree of air movement. When an individual is surrounded by dead air, without movement, and a warm temperature containing considerable moisture, conditions are present which prevent the elimination of heat and moisture from the body. Such a condition produces deleterious influences in two ways: first, it prevents the elimination of harmful products; and, second, it fails to furnish the surface stimulation necessary for hastening general cellular activity. The result is that the patient shows some of the following symptoms: feelings of discomfort, oppression, headache, faintness, and drowsiness. The evil effects of this may be mitigated by keeping the air in motion,—thus electric fans render very valuable service in a closed room, and add greatly to the individual's comfort and well being. Individuals who live in badly ventilated rooms with their bodies surrounded by stale air, lack nerve tone as well as physical tone, and suffer from a low state of metabolic activity. The converse is true of those who live in the open. Their cellular activity is stimulated and their nerve and physical tone is greatly improved.

In discussing the effect of open air, or climatic conditions, which depend upon these various chemical and physical properties of the air, one cannot discuss them apart from other influences. We cannot say that putting a patient in the open air will do this, or that, and confining him in a closed room will do the opposite; but we must understand that such a course has a tendency to produce such and such results, unless these be counteracted by other influences.

The proof of the importance of the physical effect of open air upon the organism furnishes us a rational basis whereby we should modify our general application of air in the treatment of tuberculosis.

Hill's contribution to this subject is so valuable that I wish to quote it extensively:

"The evil effects of confined and crowded rooms, according to the chemical theory, leaving aside infection, are attributed to the following suppositions:

(1) that the air becomes impoverished of oxygen;
(2) that it contains excess of carbon dioxide gas;
(3) that it contains an organic poison from the expired air which has been added to the atmosphere.

"Little attention has been paid to such points as the temperature and movement of such an atmosphere or to the amount of water vapor contained in it. Yet common observation shows that it is of the heat and want of movement of the air that people always complain: 'How close and warm it is.' 'There is not a breath of air,' etc.

THE SUPPOSED DIMINUTION OF OXYGEN.

"The oxygen in the most crowded room is never diminished by more than one per cent—since cracks and crannies are always admitting the outside air. This is seen from the following table:

Open country or sea	20.95
Streets of London	20.888
Backs of houses	20.70
Pit of a theater (11.30 p. m.)	20.75
Court of Queen's Bench	20.65
Lecture theater (before and after lecture) (Sorbonne)	20.28—19.86
Cowhouse	20.75

(Russell[5])

"Such a diminution of one per cent has no physiological effect. Indeed, for the purposes of open air treatment cases are sent to health resorts 5,000 feet up in the Alps, where the partial pressure of oxygen is considerably less than ever it can be in the most crowded room.

"The barometer may vary at sea-level between 28 and 31 inches—equivalent to a 10 per cent variation in the partial pressure of oxygen in the atmosphere.

"So long as there is present a partial pressure of oxygen sufficient to change most of the hemoglobin of the venous blood into oxyhemoglobin during its passage through the lungs there can arise no lack of oxygen. At sea-level the pressure of oxygen in the pulmonary alveolar air is about 100 mm. Hg.—only two-thirds of that in the atmosphere. Exposed to only one-half this pressure, the hemoglobin is more than 80 per cent saturated with oxygen. A person not exerting himself will fail to observe any effect until the oxygen has been reduced to 12 to 10 per cent of an atmosphere, and consciousness will not be lost until the percentage sinks below 7 per cent."

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[5] The Atmosphere in Relation to Human Life and Health, Smithsonian Miscellaneous Collections, 1896, vol. xxxix, No. 1072.

THE SUPPOSED EFFECT OF EXCESS OF CARBON DIOXIDE.

"Analyses show that in a confined atmosphere the amount of CO_2 never rises to any great extent, e.g.:

London (Summer average)	.0379
Court of Chancery	.20
Workshop	.30
Pit of theatre	.32
Crowded meeting	.365

(Russell)

"A great deal has been made of the ill effects of excess of carbon dioxide in the air—and in regulations for certain trades under the English Factory Acts only a few parts per 10,000 are permitted in the air. Physiological inquiry has, however, proved that the excess in the atmosphere cannot enter the body.

"This is because the respiratory center acting in response to the hydrogen-ion concentration of the blood normally keeps the CO_2 content of the pulmonary air constant at about 5 to 6 per cent.[6]

"The only result from breathing .5 per cent CO_2, a slight excess to the physiologists but regarded as enormous by the hygienist, is an unnoticeable increase in the ventilation of the lungs. The increased ventilation is so adjusted as to keep the concentration of CO_2 in the lungs at the normal 5 to 6 per cent of an atmosphere. When we take gentle exercise and produce more CO_2 in our bodies, the pulmonary ventilation is similarly increased, and thus the concentration of CO_2 in the lungs and blood is kept constant.

"Haldane and Priestley found that with a pressure of 2 per cent of an atmosphere of CO_2 in the inspired air the pulmonary ventilation was increased 50 per cent; with 3 per cent, about 100 per cent; with 4 per cent, about 200 per cent; with 5 per cent, about 300 per cent; with 6 per cent, about 500 per cent. With the last, panting is severe, while with 3 per cent it is unnoticed until muscular work is done, when the panting is increased 100 per cent more than usual. With more than 6 per cent the distress is very great, and headache, flushing, and sweating occur. With more than 10 per cent there occurs loss of consciousness after a time, but no immediate danger to life. Even exposure to 25 per cent may not kill an animal within an hour or two. Such high concentrations, when breathed with sufficient CO_2, poison the heart and lower the blood pressure.

"It is only when the higher concentrations of CO_2 are breathed, such as 3 to 4 per cent of an atmosphere, that the respiration is increased so that it is noticeable to the resting individual; but percentages over one per cent diminish the power to do muscular work, for the deep breathing due to the work is increased by the effect of the CO_2 in the atmosphere. In submarines it is found that the men can endure concentrations up to 3½ per cent without any great difficulty, the oxygen at the same time being correspondingly diminished.

"The writer and Martin Flack[7] found that rats huddled together in their sleeping chamber breathe from 2.8 to 5 per cent of CO_2 in preference to being out in the cold open part of their boxes. They come outside when the air within becomes too warm and moist. In the room of a brewery where CO_2 is compressed into cylinders the men work regularly in an atmosphere of .9 to 1.48 per cent of CO_2. No deleterious effects have resulted after many years at the employment.[8]

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[6] Haldane and Priestly: Journal of Physiology, 1905, vol. xxxii, p. 225.

[7] Hill, Flack, McIntosh, Rowlands, and Walker: The Influence of the Atmosphere on Our Health and Comfort in Confined and Crowded Places, Smithsonian Miscellaneous Collections, 1913, vol. ix, No. 23.

"Lehman found in a brewery 1.5 to 2.5 per cent of CO_2 in the air of the fermentation rooms. This was breathed by five to eight workers for hours every day with no ill effects. All were strong, healthy men, some having done the work for years.

"At each breath we rebreathe into our lungs the air in the nose and large air-tubes (the dead-space air); about one-third of the air breathed by a resting man is dead-space air. Thus, no man breathes in pure outside air into his lungs, but air contaminated perhaps by one-third or (on deep breathing during muscular work) by one-tenth with his own expired air. When a child goes to sleep with its head partly buried under the bed clothes, and in a cradle confined by curtains, it rebreathes the expired air to a still greater extent; and so with all animals that snuggle together for warmth's sake.

"To rebreathe one's own breath is a natural and inevitable performance, and to breathe some of the air exhaled by another is the common lot of men who, like animals, have to crowd together and husband their heat in fighting the inclemency of the weather.

"Carbonic acid can therefore be dismissed as having nothing whatever to do with the ill-effects of confined atmospheres.

The Supposed Existence of Organic Poison in Expired Air.

"A great deal has been made of the supposed existence of an organic poison in expired air in all the popular books on hygiene, but when we come to examine that question we find that there is no evidence worth anything at all as to the existence of this poison.

"Evidence for such a poison was first brought forward by Brown-Séquard and D'Arsonval.[9] They expired through a vessel surrounded with ice and the water exhaled in the breath was condensed. They took that condensation water and injected it into animals, which were said to be poisoned by it. Therefore, it was argued, there was poison in this condensation water which was exhaled. Another experiment was to put a number of animals in separate glass vessels and draw the air from vessel to vessel, so that animal No. 6 was breathing the air which had come through the other five vessels where the other five animals were. They said that Nos. 6 and 5 got poisoned, while Nos. 1 and 2 remained in perfect health. A great many trustworthy and skilled investigators have now repeated these experiments, and found no evidence in favor of the existence of these poisons.[10] It has been shown that why these animals died in the last boxes, Nos. 5 and 6, was because errors of technic were made; the tubes were wrongly placed, and leaked so that the current of air did not come through, and the animals were asphyxiated from want of air; or else the current of air was made so slow that the last animals were given something like 15 per cent of carbonic acid to breath, a poisonous amount.

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[8] Loc. cit.

[9] Loc. cit.

[10] Dastre and Loys, Russo Gilberti and Alessi, Hermans, Lehmann, Haldane and Lorrain Smith, Jessen Paul, Ercklentz, etc.

"The writer and Martin Flack have tackled the question in a very simple way.[11] They took a number of deep boxes and put a number of guinea-pigs and rats at the bottom having the lids shut down to such an extent that day and night there was more than 1 per cent of carbonic acid in the boxes. There the animals lived; thoroughly cleaned and well-fed, and breathing in the exhalation of their own breath day after day, with the ventilation so arranged that at least one per cent of carbonic acid (produced by themselves) was in the boxes. These animals did not suffer; they lived in the boxes for months. They begot young under those conditions. They were removed when pregnant to other boxes because such conditions were not favorable to the mothers actually giving birth to the young. Young ones placed in the boxes exhibited no sign of poisoning, but grew and thrived.

"In regard to the first type of D'Arsonval experiment the evidence has been conflicting, but the most trustworthy workers agree that the fluid condensed from the pulmonary exhalations of man has no toxic or specially injurious effect when injected into animals, and there is no evidence that such fluid contains an organic poison."

THE EFFECTS OF HEAT STAGNATION.

"While evidence in favor of the chemical view is lacking, evidence in favor of the view that the discomfort of confined atmospheres is really due to temperature—excess of water vapor and lack of air movements causing heat stagnation—is very convincing.

"No less than thirty years ago Hermans[12] found the evidence in regard to the bad effects of the chemical impurities insufficient, and suggested that the results of bad ventilation are thermal in origin. Susceptible individuals suffer from oppression, headache, sickness, and may faint under certain conditions in crowded rooms. The symptoms resemble those experienced in the open air on excessive hot and humid days. The axillary temperature may be raised 0.3° to 0.6° C. in a hot theater. Heat and moisture increase very greatly in crowded places where the occupants are jammed together and the usual channels of dissipation of body heat are checked. Flannel and linen garments may increase in weight 13 to 14 per cent. The wetness of the clothes increases the unpleasant feelings and the danger of chill on coming out of warm rooms into the outer air.

"Under the direction of Flügge[13] a series of admirable experiments have been carried out on this question in the Institute of Hygiene in Breslau by Heymann, Paul, and Ercklentz.

"Normal individuals were placed in a cabinet of three cubic meters capacity, and shut within it for periods up to four hours until the CO_2 percentage rose to from 1.0 to 1.5. No symptoms of illness or discomfort were felt, and the chemical impurity of the air had no influence on the power to carry out ergographic tests, or mental computations, so long as the temperature and moisture of the air were kept low. Paul shut a man in the chamber for 4¾ hours. The temperature rose to 24° C., the relative humidity to 89 per cent, the CO_2 to 1.2 per cent. He was very uncomfortable. Those who, from outside the chamber, breathed the air within through a tube and mouthpiece, felt no discomfort. Immediate discomfort was felt by one who went into the chamber. In another experiment the temperature was 30.2° C., relative humidity 87 per cent, CO_2 1.1 per cent. Symptoms of discomfort were pronounced although the subject breathed pure air from outside through a mouthpiece. The symptoms were allayed by a fan which impelled the air in the chamber at a rate of a few meters per second.

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[11] Loc. cit.
[12] Archiv für Hygiene, 1883, vol. i, p. 1.
[13] Zeitschrift für Hygiene, 1905, vol. xlix, pp. 363, 388, 405 and 433.

"When the chamber was cooled to 17° C., there were no symptoms of discomfort although the CO_2 rose to 1.6 per cent.

"The writer, with Martin Flack, R. A. Rowlands, and H. B. Walker, has confirmed and extended these results. They used an experimental chamber, constructed of wood, with large observation windows, and rendered air-tight by filling up all cracks with putty and pasting the interior with several layers of brown paper. The temperature could be elevated by means of electric heaters, or cooled by a coil through which cold water could be circulated. The amount of water vapor could be raised by placing vessels of water over the heaters, and the air moved by means of electric fans placed in the roof. Wet and dry bulb readings were taken at about chest height. The chamber held approximately three cubic meters of air. In one class of experiments seven or eight students were shut within the chamber for about half an hour, and the effect of the confined atmosphere upon them observed. They were kept there until the CO_2 reached 3 to 4 per cent, and the oxygen had fallen from 17 to 16 per cent. The wet bulb temperature rose meanwhile to about 82° to 85° F., and the dry bulb to a degree or two higher. The students went in chatting and laughing, but by and by, as the temperature rose, they ceased to talk, and their faces became flushed and moist. Some tried to light a cigarette (to relieve the monotony of the experiment), and were puzzled by their matches going out. They had not sensed the diminution of oxygen, which fell below 17 per cent. Their breathing was slightly deepened by the high percentage of CO_2, but no headache occurred in any of them from the short exposure to from 3 to 4 per cent CO_2. Their discomfort was relieved to an astonishing extent by putting on the electric fans placed on the roof. While the air was kept stirred the students were much less affected by the oppressive atmosphere. They begged for the fans to be put on when they were cut off. The same stale air containing 3 to 4 per cent CO_2, and 16 to 17 per cent O_2, was whirled, but the movement of the air gave great relief, because the air was 80° to 85° F. (wet bulb), while the air enmeshed in their clothes in contact with their skin was 98° to 99° F. (wet bulb). The whirling away of this stationary air cooled the body effectually, for the air can hold considerably more water vapor at 98° to 99° than at 80° to 85°. (If the wet-bulb in the chamber registered 99° F. whirling the air would have given little relief.)

"The air of the chamber breathed by other students outside caused no discomfort, whereas a student inside, breathing the outside air felt no relief.

"The pulse frequency was diminished in each case by putting on the fans, and the discomfort relieved.

"In other experiments the subject breathed through a very sensitive meter fitted with a mouthpiece, an inlet and an outlet valve. A soda-lime tin, to absorb CO_2, was at times interposed between the inlet and the mouth. The effect on the respiratory ventilation and on the pulse rate was recorded both when resting and when working. The work consisted in pulling up a 20 kilogram weight about one meter high by means of a pulley and a rope.

"In many of the experiments CO_2 was put into the chamber from a bag full of gas. The subjects inside could not tell when the gas was introduced, not even if the percentage was suddenly raised to 2.

"The introduction of this amount of the gas made no sensible difference to them. The subjects wore only a vest, pants and shoes in most of these experiments. When they wore their ordinary clothing the effect on the frequency of the pulse was more marked, and the discomfort from heat and moisture much greater.

"In every one of the experiments the putting on of the fans gave great relief. The measured quantity of work was then done with less acceleration of the pulse rate. The refreshing effect of the moving air acting on the skin was very great, but this could not be measured and recorded in figures.

"Heat stagnation is, therefore, the cause of the discomfort, and the symptoms arising in the so-called vitiated atmosphere of crowded rooms are dependent on heat stagnation. The moisture, stillness, and warmth of the atmosphere are responsible for the effects, and the efforts of the heating and ventilating engineer should therefore be directed toward cooling the air in crowded places, and cooling the bodies of the people by setting the air in motion by means of fans. The strain of the heat-regulating mechanism tells on the heart. The pulse is accelerated, the blood is sent in increased volume to the skin and circulates there in far greater volume, while we must assume that less goes through the viscera and brain. The observations of Hewlett show that the velocity of blood-flow in the arm may be increased three to eight times when the subject is in a hot atmosphere, while cooling the atmosphere may reduce it to one-quarter the velocity which pertains in normal conditions.[14] In a hot moist atmosphere the surface temperature rises, the cutaneous vessels dilate, the veins become filled, the arteries may become small in volume and the blood pressure low, the heart is fatigued by the extra work thrown upon it. The influence of the heat stagnation is shown by the great acceleration of the pulse when work is done, and the slower rate at which the pulse returns to its former rate on resting.

"The increased percentage of carbonic acid and the diminution of oxygen which have been found to exist in badly ventilated churches, schools, theaters, and barracks, are such that they can have no effect upon the incidence of respiratory disease and the higher death rate which statistical evidence has shown to exist among persons living in crowded and unventilated rooms. The conditions of temperature, moisture, and windless atmosphere in such places primarily diminish the heat loss, and secondarily the activity of the occupants, as also the total volume of air breathed, oxygen taken in, and food eaten. The whole metabolism of the body is thus run at a lower plane, and the nervous system and tone of the body are unstimulated by the monotonous, warm, and motionless air. At the same time, the number of pathogenic organisms—saliva spray infection—is increased in such localities, and the two conditions run together—diminished immunity and increased mass influence of infecting bacteria.

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[14] American Journal of Medical Sciences, 1913, vol. xv, p. 656.

"Another point of great importance in connection with a warm confined atmosphere is its effect upon the mucous membrane of the nose. This has been clearly demonstrated by F. F. Muecke in conjunction with the writer.[15]

"Under normal conditions when a person comes in from cool surroundings, a cool atmosphere, or the outside air, the mucous membrane is shrunk; it is taut. If touched with a probe it does not pit, it is not congested, and there is very scanty secretion. The effect of going into a heated chamber where the air is at a temperature of about 80° F. and the wet bulb not much lower, conditions such as exist in crowded places, meeting houses, or ballrooms, is that the mucous membrane of the nose becomes turgid with blood and covered with a very thick secretion, while the tissues are swollen. A probe pushed into the tissues forms a pit showing how boggy they are. The airway is so diminished that a person with a spur or any kind of obstruction cannot breathe through the nose when in these hot conditions. The effect of putting on a pan in a hot room and whirling around the same air is to lessen the obstruction of the air channels. Going out into the open air for a few minutes, especially cool open air, causes the blood vessels to contract, but one still finds that the mucous membrane is boggy, that it pits, and that there is a great deal of thick secretion upon it. Thus, when a person goes into warm, moist places the mucous membrane becomes greatly swollen; there is a great deal of lymph tissue in it, a great deal of thick secretion; the exhaled bacteria that are thrown in masses on it are caught in the thick secretion. Then on coming out into the cold again the blood vessels shrink up so that heat should not be lost from the body, and the nasal mucous membrane is left containing thick secretion and a great deal of tissue lymph, a medium for the growth of bacteria, while it loses the blood that defends it from infection. When the mucous membrane is kept taut, as in cool air, the flow of blood is rapid, the inhaled air is warmed up quickly and moisture evaporates from the nose so as to saturate this air at body temperature; more plasma comes out of the blood vessels, and this contains the immunizing substances. The ciliated cells are well supplied with plasma, and they lash well, and the offensive bacteria are kept out. But in the condition where there is much secretion and boggy tissues and the blood has been shrunk out by vasoconstriction then there is a suitable nidus for bacteria to grow in.

"In many buildings the ventilation system is such that the feet are cooled more than the head. The draught on the feet causes swelling of the nose, feeling of 'stuffy head,' and obstruction of the air way. Methods of heating and ventilation should be contrived so as to secure warm feet and cool heads, the conditions which pertain out of doors on pleasant days."

Hill found that the thermometer fails to demonstrate the conditions which we feel and devised an instrument which he has called the katathermometer, which shows the rate of heat loss.

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[15] Lancet, London, May 10, 1913.

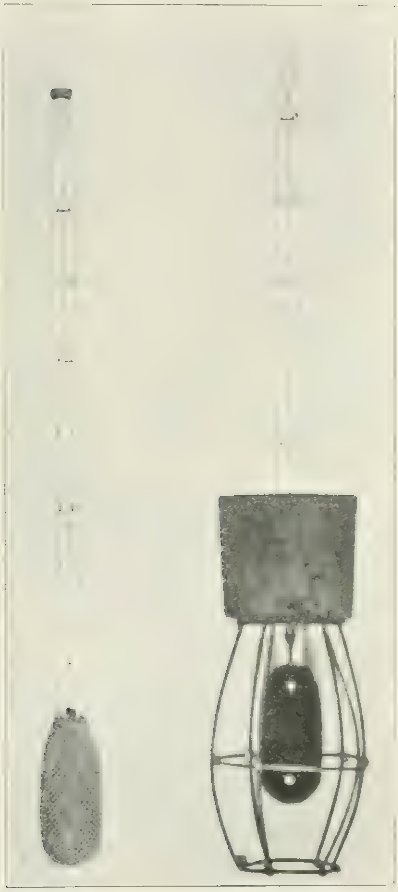

Fig. 129.—The wet and dry katathermometer. The dry instrument is shown enclosed in a wire cage, which is used for taking observations between the skin and shirt. (Hill.)

> "It consists essentially of a large-bulbed spirit thermometer graduated from 110° F. to 90° F. with distinctive marks on the stem at 110°, 100° and 90°. (See Fig. 129.)
>
> "Two such instruments are generally employed—one with the bulb uncovered, the dry katathermometer—the other with the bulb covered by a fine cotton mesh—the finger of a lady's thin glove. To employ the instrument the bulbs are immersed in water at about 150° F. until the spirit rises into the small bulb at the top of the instruments. The excess of water is then jerked off the wet bulb, and the other dried. The instruments are then suspended in air, and the rate of cooling from 110° to 100°, and from 100° to 90° taken with a stop watch. The wet bulb loses heat by evaporation—the dry one by radiation and convection.
>
> "The instrument has been graduated by taking many observations under a great variety of conditions, both indoors and outdoors. The readings obtained in conditions which appear to the sensations as ideal have been taken as the empirical graduation of the instrument. Such indoor readings in particular give the standard to be aimed at in the heating and ventilation of buildings."

The experiments performed showed that on an ideal summer day out of doors the wet bulb required 25 seconds to fall from 110° to 100°, while the dry bulb required 85 seconds. Indoors, at the seaside in the summer, on an ideal day, under pleasant and comfortable conditions, the readings were 50 seconds and 140 seconds respectively.

In a hot chamber the readings were much longer, denoting heat stagnation of the body, the longer the time of reduction in temperature, the greater the degree of heat stagnation.

In some experiments which were performed in flax-spinning sheds, it was shown that "when only a cotton shirt is worn, putting on the fan increases the rate of cooling of the 'skin-shirt' air by 100 per cent or more, depending upon proximity to fan, whereas when more than one garment is worn, e.g., a closely woven vest and waistcoat, the rate of cooling is not increased to the same extent."

This gives important suggestions for conditions which produce comfort during work.

Observations of respiratory metabolism were made on eight individuals who sat quiet for successive half hours, first in a room and then on the roof of the London Hospital Medical College, exposed to cold wintry weather. In either case the subjects wore their ordinary indoor clothes.

> "In every one the pulmonary ventilation, the CO_2 output, and O_2 intake are notably increased by the 'open air treatment.' In three of

> these subjects measurements were made on the roof first when a hot-water bottle was applied to their feet and a couple of rugs covered their bodies from the waist down, secondly, when these were removed. The table (in the original, but omitted here) shows that the cooling of the face and hands excites in them an increase of metabolism, but this increase becomes greater when rugs and hot-water bottles are removed. On still misty days when the temperature is nearly freezing, the metabolism is increased but little compared with that on days on which the temperature is the same, but on which a strong wind is blowing.''

These observations are important in our methods of subjecting patients to open air treatment.

Hill further says:

> ''There must be a certain degree of increased rate of cooling in addition to the sensation of cold before any marked increase of metabolism results.
>
> ''The katathermometer readings indicate that this occurs when the rate of cooling of the dry bulb from 110° to 90° is reduced from about 300 seconds indoors to or below 100 seconds out of doors. The mechanism by which body heat loss is controlled compensates for the increased cooling effect of the atmosphere within wide limits. The katathermometer readings, which were taken between the skin and shirt on the East Coast, show a cooling effect which is greater out of doors on the more bracing days. The readings were taken at the seaside with the coat open, no waistcoat was worn, and the instrument placed under a thin cotton cellular shirt. In the winter, flannel vest, shirt, and waistcoat were worn, and the instrument placed under all these. A greater rate of cooling is noticeable in the readings taken on cold winter days as compared with those taken indoors, but the clothes compensate largely for the greater cooling effect of the atmosphere. Out of doors in the bracing summer days on the East Coast, the clothed part of our bodies was immediately surrounded by air which permitted a rate of cooling somewhat greater than that which pertained in the roof experiments on cold winter days. Indoors in London the rate of cooling in the cold winter days was less than at the seaside in the summer. The room in London was very moderately warmed by a gas fire, and the window was kept open at the top about 9 inches. The metabolism indoors at the seaside in the summer was decidedly greater than that indoors in London in the winter. More food was eaten, and a life of greater activity led at the seaside. In the cold winter days out of doors the hands and face experience much greater sensations of cold than at the seaside.
>
> ''While on cold misty still days everyone feels cold and uncomfortable, katathermometer readings show that the rate of heat loss is not great, it may, indeed, be much greater on a bracing summer day at the East Coast, when the wind is blowing and the conditions are pleasant and invigorating.
>
> ''Our observations show also that the oxygen use and CO_2 output is not increased on these days as it is on a bracing windy day. The cold feeling is not then due to increased body heat loss, but to cooling of the specific cutaneous nerve endings—the cold spots. In a cold mist these

cutaneous nerve endings are exposed to the cooling effect of the water particles in the air (the heat capacity of water per unit volume is 3,000 times that of air, and the conductivity 200 times) perhaps almost at freezing temperature, and the amplitude of the sensation of cold depends on the difference between the blood heat of the skin and the cold atmosphere outside the skin. On a bracing windy day the cutaneous vessels constrict in order to reduce heat loss, and the air in contact with the skin is relatively dry. Relatively more blood is sent to the skin on the still foggy day. Thus the temperature gradient to which the nerve organs are exposed is much less steep on the bracing day than on the cold misty day. Our immediate feelings of comfort depend rather on our cutaneous sensations than on the rate of body heat loss.

"When cold misty air laden with droplets of moisture enters the nose, these droplets must be evaporated before the air can be warmed to body temperature. This both cools the mucous membrane of the nose and lessens the evaporation of moisture from it. In this fact we may perhaps find the explanation of why sudden changes of weather and the going from hot rooms to cold damp air may start 'colds' in the head.

"The effect of exercise and sea bathing on L. H. and M. F. is shown in the following table (page 242).

"It is instructive to note how a walk of three miles an hour trebles the pulmonary ventilation and respiratory exchange while a sea bath sends these up to more than ten times the resting value. The sea bath increases the pulmonary ventilation to such a degree that CO_2 is washed out of the body and the respiratory quotient made greater than 1.0.

"The writer suggests that an increased respiration above what is needed for the muscular effort of swimming is utilized to keep up the body temperature. So, too, on exposure to cold wind, the subject resting, the respiration is increased and for the same reason. E. R. Lyth[16] has found on himself that exposure, while resting, to the cold wind or cold moving water increases his pulse rate and he suggests that the contractions of the heart are brought into play to keep up the body temperature. Our observations do not show any clear evidence of accelerated pulse rate on exposure to cold, in many cases it is slightly slowed, but cold gusts of wind seem to accelerate the pulse.

"Wolpert[17] employed the Pettenkofer method and made observations on the effect of wind on the water vapor and CO_2 output of his laboratory servant, comparing the effect of still air in each case. He concluded that wind increased both the evaporation of water from the skin and the output of CO_2 when the temperature of the atmosphere was between 10° and 25° C. Between 25° and 35° C. wind diminished the water vapor output and had relatively less effect on the CO_2 output. Between 35° and 40° C. wind increased both the water vapor and CO_2 output. On the naked body wind had little influence when neither cold nor warm sensations were excited, e. g., at 30° C. The pulmonary ventilation was increased by wind when either the sensation of heat or cold was produced. At 35° C. moved air was more pleasant than still air to the naked resting man, and prevented him sweating. At 40° C. the wind was much pleasanter, at 20 still air was the more pleasant. Wolpert says it is

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[16] Influence of Thermal Environment, London, 1913.

[17] Archiv für Hygiene, Bd. xxiii, s. 206.

SUBJECT	PULMONARY VENTILATION PER MINUTE IN LITERS	CO_2 OUTPUT PER MINUTE IN C.C.	O_2 USED PER MINUTE IN C.C.	
M. F.	25.5	1108	1208	While riding one-third mile along cliff at rate of 1 mile in 4 mins. 42 secs.
	22.6	1103	1218	While doing Swedish exercises, 50 movements (10 movements, 5 different exercises) in 3 mins. 19 secs.
	7.4	280	329	6:20 A.M.—Resting on couch before bathing before breakfast.
	72.0	2527	2506	6:45 A.M.—Bathing, few strokes in rough water.
	8.4	337	374	8:45 A.M.—Resting on couch after breakfast.
	25.6	1065	1257	12:20 P.M.—Walking 225 yards in 2½ minutes (3 miles per hour approximately). A quiet morning.
L. H.	5.2	2438	2464	Running up sand cliff in 54 secs.
	6.8	264	306	6:25 A.M.—Resting on couch before bathing before breakfast.
	96.3	3804	3361	6:45 A.M.—Bathing in sea rough and cold.
	8.2	301	345	12:25 P.M.—After resting on couch 5 minutes. Had been analyzing gases all morning.
	24.0	1051	1138	12:50 P.M.—Walking 200 yards in 2½ minutes (2.7 miles per hour approximately).
	9.8	376.3	382	2:40 P.M.—Resting out of doors in sun and wind.
	30.9	1340	1477	3:05 P.M.—Walking 250 yards in 2½ minutes (3.4 miles per hour approximately).

pleasanter to work in an atmosphere at a temperature of 25° C and 50 per cent relative humidity than at 17° C. and 87 per cent humidity.

"Haldane finds 31-32° C. (88-90° F.) is the maximum wet bulb temperature which can be borne for several hours without marked symptoms of distress when stripped to the waist. In a good current of air 33°-34° can be borne. For fairly hard work he says 26°-27° (80.6° F.) is the maximum wet bulb for still air.

"Zuntz[18] says if the heat production of the body is increased 1,000 calories by a march taken in still air at 10° C. and saturated with moisture, and the output of water vapor is increased 800 grm., this amount will be diminished 4 grm. for each one per cent increase of relative dryness; for each increase of 1° C. in temperature raised .38 grm.; and for every unit increase in wind diminished 70 grm. (He estimates the force of the wind in a scale of 10 units.)

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[18] Lehrbuch der Physiologie des Menschen. Zuntz and Loewy, Leipsic, 1909, s. 713.

''Training has a great effect in reducing the loss of water vapor during exertion.[19] Bodily condition makes a great difference. Five subjects made the same march in uniform loaded to the same extent. The slimmest lost 953 grm., and the fattest and most solidly built 2,575 grm. of water vapor.[20]

''Wolpert[21] found that between 10° and 15° C. and up to 20° C. with relatively dry air, the water vapor output of the body was increased very little by work done at the rate of 5,000 mkg. per hour. Between 20° and 30° C. the effect of this rate of work on the vapor output was greater both in the case of relatively dry and moist air. With temperatures higher than 30° C., the increase of vapor output on doing work—compared to the resting value—was less. He concluded that the increase due to work is greatest when the atmosphere causes no sweating in the resting man but work does.

''The relative dryness of the air is most important in hot atmospheres. The three factors which make effective work possible are (1) dryness of the air, (2) the taking off of clothes, (3) air movement. According to Wolpert a naked man working in still air is worse off than a clothed man working in air moving at the rate of 8 meters a second. Clothed, at 33° C., in a relatively dry air, a man can do at most half the work he can do naked in moist air; clothed, at the same temperature, in moist air, he can only do at most quarter of what he can do naked.

''The essential thing is to keep down the saturation of the air in contact with the skin. The air entangled in the clothes becomes warmed up to body temperature, and saturated with moisture if there be no wind to drive it away.

''Wolpert[22] concluded from a series of observations made with a Robinson anemometer, that the velocity of the wind in the neighborhood of houses, especially in front of the windows and in courtyards, seldom exceeds 10 per cent of the velocity of the free wnid on the roof, and generally reaches a far smaller and even only a fraction of a percentage. He found the effect of the wind was less as he proceeded from the roof to the second, and thence to the first and ground floors.

''Eddies from the walls must neutralize the effect of the wind on the cups of the anemometer, and this instrument cannot therefore give a true measure of the effect of the wind in so far as it affects the rate of cooling of the body. He concluded from his observations made respectively on the ventilation of isolated country houses and penned-in town houses that the former receive about 50 per cent more ventilation. A country house, he says, received as much ventilation in summer as an artificially heated house in Berlin in winter.

''Observations made by us (M. Flack and L. Hill) with the katathermometer show that the rate of cooling in front of the windows of the third and second floors on the windy and exposed side of the London Hospital Medical College is little less than it is on the roof. The eddies which neutralize the turning movements of an anemometer produce cooling

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[19] Army Report on Two Experimental Marches, col. 7182, 1913.

[20] Lehrbuch der Physiologie des Menschen. Zuntz and Loewy, Leipsic, 1909, s. 713.

[21] Archiv für Hygiene, vol. xxxvi, pp. 203, 204.

[22] Archiv für Hygiene, vol. lii, pp. 22, 46.

AVERAGE KATATHERMOMETER READINGS OBTAINED OUTSIDE THE LONDON HOSPITAL MEDICAL COLLEGE.

WET KATATHERMOMETER 110–90	DRY KATATHERMOMETER 110–90	S. S. W. WIND, RAIN AT TIMES
Seconds	Seconds	W. B. 47 D. B. 48
42	86	Roof.
37	84	In front of window, 3rd floor, South (windy) side.
42	95	" " " 2nd floor, South (windy) side.
45	92	" " " 1st floor, South (windy) side.
70	156	" " " 3rd floor, north side.
69	154	" " " 2nd floor, north side.
56	145	" " " 1st (ground), north side.
50	107	" " " 3rd floor, west side.
60	120	" " " 2nd floor, west side.
65	145	" " " 1st floor, west side.
65	156	" " " 3rd floor, east side.
67	154	" " " 2nd floor, east side.
65	137	" " " 1st floor, east side.
54	114	In middle of Hospital garden.

of the katathermometer or human body and the difference of results obtained by us show how inefficient an instrument the anemometer is for determining the effect of movement of air on the human body. By our feelings we know that the effect of the wind is not reduced on the face of our houses or in courtyards to an insignificant percentage of that which pertains on the roof. We regard the katathermometer as a far more reliable and sensitive instrument.

"The results detailed above lead the writer to conclude that the curative influence of open air treatment and exercise depends on the increased metabolism of the body which is accompanied by a more ample ventilation of the lungs, more vigorous circulation, better appetite and digestion and lessened bacterial decomposition in the large bowel. He suggests that it is rather by these ways than by autoinoculation that the beneficial effects are obtained in the treatment of phthisis. He urges that the movement of the air, producing an adequate cooling of and stimulating effect on the skin, is the prime factor in ventilation, and that crowded tenements and cities owe their deleterious effects to the withdrawal of the citizens from the adequate action of moving air and sunlight, and not to any chemical impurity (leaving on one side the question of dust in the atmosphere) of the atmosphere which they breathe. There seems to be no advantage in open air treatment on cold damp days when the atmosphere is still and saturated with moisture. Exposure to such an atmosphere produces a sensation of cold owing to the water vapor in the air which cools the nerve endings in the warm skin of the face and hands; it does not produce the advantageous increase in metabolism or the stimulating effect which is produced by air movement acting on the whole cutaneous surface. Bracing places are those where the metabolism is increased most by frequent movement of cool and not too humid air. Sanatoria should not be placed in situations so sheltered that the air is apt to be

> still and overladen with moisture. It is inadvisable to surround suburban houses with trees and shrubs which blanket them with a stiller and moister air. The beneficial effect of garden cities, as far as atmosphere goes, is to be sought in the freer movement and greater relative dryness of the air both inside and outside the houses. It is well known that artificial methods of warming cannot be applied with any advantage to the raising of animal stock, and such methods should be so used by man as to diminish to the least degree the energy output of his own body, commensurate with his efficiency in work. Overheated rooms and still air decrease the activity of the body furnace and so lead to lessened vigor and resistance to disease. Particularly is this the case if overeating accompanies overheating, for the food eaten is not required to keep the body warm, and undergoes bacterial decomposition in the bowel with the consequent deterioration of health. The overheated air of rooms with the rapid changes of temperature from this air to the outside winter air leads to the disturbed function of the respiratory mucous membrane, with the consequent acquisition of 'colds' and respiratory infections. It is not the cold outside air which causes the trouble, but the overheated atmosphere of the room. The general belief that exposure to cold is the cause of all trouble is greatly to be deprecated. So far as real evidence goes, those who expose themselves freely to open air and cold weather become hardy and vigorous and do not take 'cold.' Excessive protection from cold weather by overclothing, overheating, and shutting out of wind lessens immunity and increases the susceptibility to such diseases as pneumonia and phthisis. The evidence of this research is in favor of open air schools, open workshops, garden cities, and means of affording sedentary workers opportunities of open air exercise to counteract the effect of their employment in still warm atmospheres. When it is generally realized that it is the physical and not the chemical conditions of confined atmospheres which influence health and happiness, a vast improvement in the condition of home and industrial life will be effected."

How Outside and Inside Air Differ.—It can readily be seen from the foregoing quotation from Hill that there are important factors in the outside air that are rarely contained in the inside air; or, if they exist at all, are found to a lesser degree. The outside air has greater motion. It does not become stagnant and by the greater motion and freedom from stagnation there is transmitted to the patient a certain degree of surface stimulation, which excites the metabolic activities of the entire organism. There is further removed from the surface of the individual, heat, moisture, and various excretory products.

The motion of the air is a great factor in its cleansing. The danger from bacterial contamination is much greater in stagnant air than in live air. In the confined air of houses bacteria live for a prolonged period of time; while, in the open air, if it has wind movement and direct light, they are destroyed much quicker. While the air of the house may be made to approach that of the open, it is rare that it contains the maximum stimulation that is found out of doors. Cross ventilation is desirable in all rooms where it can possibly be attained because it guarantees a movement of air which is a necessary factor in obtaining the maximum stimulation.

The ill effects upon the patient in rooms that are poorly ventilated depend upon several factors. Patients living in such rooms lack the stimulation upon the skin which comes from the open air. The air which surrounds the body is confined by clothing. It contains more moisture than the air outside of the clothing and preserves a higher temperature. Marked air movement is necessary in order to cause a change in this layer of air inside the clothing; and without its change the functions of the skin are sluggish and the body cells lack a favorable stimulation. Aside from the physical effects of open air, those who dwell in closed rooms live in an environment which favors further infection. It is well known that patients occupying a small space in crowded, poorly ventilated rooms, have little chance of overcoming tuberculosis. They fail to obtain the stimulating benefit of open air; and, consequently, the functional capacity of their body cells is low. They possess a low degree of resistance, not only to tuberculosis, but to other bacterial diseases with which they come in contact. They are more prone to infections by such microorganisms as streptococci, staphylococci, influenza bacilli, and the germs responsible for colds, bronchitis, and other similar infections which prove deleterious. The environment in which they live is also more favorable to the life of such microorganisms and furnishes the opportunity for such infection.

Almost all acute respiratory infections are transmitted by intimate contact, and the danger is much greater in confined rooms than it is in the open. This was impressed upon me very strongly this last winter during the epidemic of acute respiratory diseases which was prevalent throughout the country. Of forty patients under my care, living in their homes in Los Angeles and the surrounding country, everyone became infected; while of eighty patients in the sanatorium who were constantly in the open air, and spared association in close rooms with those who were infected, only ten became ill, and four of these brought the infection with them when they entered the institution. Of the attendants and employees of the sanatorium, who left the sanatorium grounds and mingled with people in their homes, about 50 per cent had the infection. Even their association with the patients in the open air did not transmit the disease.

Another very important effect of outside air is that it accustoms the patient to various climatic changes, and increases his resisting powers to such an extent that he maintains his normal physiological equilibrium regardless of the changes in temperature, moisture, and air movement. When the out-of-door life is properly carried out, the patient will remain in the open practically all the time. If it is necessary for him to spend part of his time indoors, the room should be kept well ventilated and not too warm. It is impossible to properly harden people if we still permit them to go freely from the cold of the open air to heated rooms, especially where they sit around hot stoves, registers, and fireplaces. After leaving the warm atmosphere the cold is much harder to endure. It is surprising to know the degree of cold that patients can endure in comfort, providing they are properly directed and hardened when taking the cure. In rigorous climates of the north, patients may be wrapped in warm blankets and furs and kept in the open when the temperature is extremely low, without discomfort or harm. In the warmer southern climate patients can sit, or recline, in comfort on the coldest days, with the protection of a rug or shawl. While it is much easier to live out of doors and enjoy open air life in the more favored climates, yet it can be done in the most rigorous.

Considerable judgment should be used in exposing patients to the open air. Individualization in the dosage of open air is just as important as in other remedies. It hardly seems the part of wisdom suddenly to subject patients with very low resisting power to the severe conditions of many of the rigorous climates without first increasing their reacting powers by other appropriate measures. Patients with apparently low resistance can often, however, with a little care, have their metabolism so improved that they may eventually be subjected to the severest cold without harm. *The benefit that is to accrue is not from putting the patient in the open air, but from the reaction on the part of the patient when placed in the open air;* consequently, it is not the cold that is valuable, but the degree of cold to which the patient is able to react.

Open air soothes the nervous system. Restless sleep and insomnia are often greatly benefited by it. Neurasthenia, which is common in this disease, improves. As a result of these benefits, the functions of the internal viscera are carried on more effectually. The appetite improves, digestion is carried on more perfectly, the bowels move more regularly, the heart action slows and strengthens, temperature becomes lower, and all vital functions are quickened.

The most noticeable improvement in patients who are taken from bad hygienic surroundings and placed in the open air is a better appetite. Metabolic activities are increased; there is a greater demand for food, and the digestive organs are given increased power to care for the food when taken. As a result of this, a gain in weight is almost universal. We sometimes see a gain in weight in patients in whom permanent improvement is impossible. The degree of improvement to be noticed depends very often upon the previous surroundings of the patient. If the hygienic conditions under which the patient has been previously living, are bad, the contrast is greater and the effects more noticeable than when the change affected is less marked.

As a result of the improved metabolism the patient's resisting power is increased; he is better able to take care of his toxins; and, as a result, temperature is lowered. Temperature may also be lowered by an increased radiation of heat. Open air improves the ventilation of the skin and in this way increases the abstraction of heat.

The effect of open air upon the tuberculous patient is so marked that this measure is being applied quite successfully to diseases in general. In fact, the fresh air movement in the treatment of tuberculosis has done far more good to the human race in general than it has to the tuberculous patient. The open air campaign is bearing fruits in greater care for ventilation in the homes, sleeping porches, better ventilated workshops, and open air schools. As a result of this, the span of life will be markedly lengthened.

The Method of Instituting Open Air Treatment.—Technic is as important in medicine as it is in surgery. There is a technic for employing even so simple a remedy as fresh air. It would be a manifest error to remove all patients from warm rooms to the cold air regardless of the stage of the disease and their resisting power on the one hand, and the weather conditions prevailing on the other hand.

When it is decided to place the tuberculous patient on a given line of treatment, fresh air is always included as one of the measures. In undertaking the treatment of a chronic disease like tuberculosis it is essential to obtain the confidence of the patient. Every step must be taken carefully, looking toward that end. A misstep will often cause a loss of confidence and an unwillingness on the part of the patient to cooperate further; consequently the physician must arrange the details accurately, looking toward the patient's comfort. He must not be content to tell the patient to live in the open air, but he must tell him how to live in the open air. If the patient has not been accustomed to living in the open it is the duty of the physician to give accurate instructions so that he may enter upon the new regime with ease and comfort, if possible,—at least, without doing himself harm.

Tuberculosis is a debilitating disease. Patients who are suffering from it, if they have passed the early stage, are more or less reduced in vitality. When adjusting themselves to open air, care must be exercised that the patient is kept sufficiently warm. No good can come from a chilling of the body. In our climates here in the southwest we experience little difficulty. The patient may be taken from closed rooms and placed in the open air without any great extra demands being made upon his reacting powers, for our days are warm and comfortable and our nights rarely accompanied by temperature below freezing. Such is not the case, however, in the northern winters.

While it is extremely desirable that as little clothing be used as possible, yet the comfort of the patient must be considered in each individual case and the amount of clothing adapted to his individual needs. Personally, I am very much opposed to the constant use of hot water bottles, electric bed warmers, and such artificial heat contrivances. I much prefer a warm garment next to the skin and such attention to the reacting powers of the patient as will bring him to the point where the cold can be withstood with ease. My objection to these artificial methods of heating is that they dry the skin and interfere with its reactivity; and, in the end, make the patient less resistant. In the coldest climates, however, it is essential at times that they be resorted to until the patient is warm; but, where the patient can attain such a degree of reactivity as to dispense with all artificial methods of heat, it should be done.

In cold weather there is no objection to having the bed warmed by a hot water bottle, providing it is removed as soon as the covers are warmed.

If patients will see that their feet are warm before retiring, they are not so apt to suffer from cold during the night.

Improvement is usually noticed so promptly after patients are placed in the open air that they are soon committed to the regime, in spite of its unpleasant features.

Clothing for the Tuberculous.—In order to obtain the maximum benefit from open air, attention to clothing is necessary. As a general rule, people who can afford it, wear too much clothing. On the other hand, among the poor, many wear too little. A good general rule is to wear the least amount of clothing that can be worn without discomfort. The excess of clothing, enveloping the patient, has a bad influence upon the skin. If it is sufficient to cause perspiration the skin is macerated, and, in this way, its tone becomes lowered and elimination is interfered with.

Too much clothing also prevents the exchange of air and thus deprives the skin of its stimulating effect. Patients derive great benefit from exposing themselves to the air for some portion of each day, as a part of the regular treatment. While heliotherapy can only be carried out successfully in countries with a large percentage of sunshine, air and light therapy can be used to advantage anywhere.

Patients who dress too warmly find it difficult to harden themselves. While subjecting themselves to conditions which require a healthy active skin they interfere with its nutrition and function by their clothing. Heavy clothing prevents skin ventilation and keeps the body surrounded by stagnant air, which depresses the vital functions.

There is considerable difference in opinion as to the best underclothing for patients to wear. It seems to me, all things considered, that linen is the least objectionable, although in colder countries it may have to be covered with a light woolen garment during the winter; or, during the most rigorous season it may have to be replaced by wool, or wool and cotton. Underclothing should not fit too tightly, nor should it be too thick. Ventilation of the skin is extremely important. The advantage of linen is that it absorbs moisture and gives it up readily. Wool, on the other hand, retains moisture. Many patients are instructed to keep themselves warm, and punish themselves by wearing heavy undergarments. This is a part of the old chest protector regime that should soon give way to judgment and good sense. I am in the habit of telling my patients that the best weight of underclothing is one that makes them comfortable, providing they follow out hygienic lines of living. Greater harm will come from underclothing that is too heavy than from that which is too light.

Proper attention to the feet adds greatly to the comfort of those who are attempting to live in the open air. No one can be comfortable with cold feet. There are certain conditions present in tuberculosis which tend to produce this condition or accentuate it if it was present prior to the onset of the disease. Vasomotor disturbance which is so common in tuberculosis, causes an interference with proper circulation, and this manifests itself particularly in the lower extremities. The deficient inspiratory act caused by the disease in the lung with its interference with the return flow of blood, favors delayed circulation. Aside from the measures directed toward the general improvement of the patient, there are others which may be directed directly to the feet themselves, which will help. Patients who suffer greatly from cold feet may relieve the condition to a certain extent by friction. This friction is more effective if patients will plunge their feet first in hot water and then in cold, alternating from hot to cold several times; and finally, after taking them out of the cold water, giving them a thorough rubbing.

The feet can also be helped greatly by such simple hygienic measures as frequently changing stockings and shoes. The stockings should be light so that perspiration, with its resultant maceration of the skin, is avoided. The wearing of woolen stockings when going to bed will often relieve this condition and make the patient's night comfortable.

Conditions of Weather and Open Air.—There is a great prejudice against open air during foggy and rainy weather, and I find that physicians hold this prejudice as much as laymen. At the time of rain or fog the atmosphere is often purer than when it is dry. The supposed harm that would come from living out during wet or foggy weather is not as great as what would actually occur from living in the house. There is no reason why windows and tent curtains should be closed during rainy or foggy weather, unless during rain it is necessary to keep the patient from exposure to wet; or the patient's reacting powers are not sufficient to keep up the body warmth. Damp open air is much less harmful than damp stale air. This prejudice against damp air is much like that against night air. There is a great horror in the minds of some people at the mention of night air. The truth is that night air is purer than day air because it is free from a great deal of the dust which is stirred up by street traffic and other activities carried on principally during the day. The prejudice against night air is based upon a faulty conclusion. Young men and women who run out at nights and interfere with their sleep, engaging in questionable pastimes, often injure their health. The blame is unjustly laid on the night air.

Open Air Not Synonymous With Exercise.—Instructions are very commonly given to the patient suffering from tuberculosis to get out in the open air. This conveys an indefinite idea to the patient. It is a meaningless instruction impregnated with harm. Following such instructions the patient very often institutes a regime of overexertion. Being in the open air means to him walking, riding horseback, riding in automobiles, climbing mountains, and engaging in strenuous out-of-door sports. Many such patients would be as well off following their ordinary work as they are in the open air. Advice to live in the open air is correct; but this advice must be accompanied by minute instructions, if success is to be attained. An individual suffering from tuberculosis should not be told that open air will cure him; but that proper living in the open air will be one of his greatest aids toward regaining health. Many a man has lived in the open air, as he thought, according to instructions, yet killed himself by overexertion or exposure.

Fresh air is only one of many important measures that can be and should be instituted to aid the pulmonary invalid in his fight for health; but one which can be had in any climate, in the city, or country, and one which is universal in its action, not affecting one organ or one group of cells only, but acting indirectly on every cell and every organ in the patient's body.

CHAPTER XXXVII.

CLIMATE.

General Remarks.—The discussion of climate naturally follows the chapter on "Open Air." Formerly climate was thought to be the chief factor in the treatment of tuberculosis, but that was before the disease was understood, and at a time when physicians felt they could do little for the disease. Today, however, we know that the most important factor in the treatment of tuberculosis is intelligent guidance. Neither open air, food, rest, exercise, psychotherapy, climatic change, tonics, bacillary vaccines or any other measure alone is a cure for tuberculosis; but the intelligent application of these various measures in proper combination will bring about an arrestment or healing in a very large percentage of cases.

There is too much of a tendency for every observer to think that the particular way in which he arrives at a result is the best way. This is obviously untrue because physicians differ the same as patients. No two physicians can carry out the same line of therapy with equal effectiveness. They must adapt it to their own particular capabilities, as well as the patient's individual peculiarities and necessities.

The great faith in climate which is still held by many is a remnant of the "let alone" policy of treating tuberculosis, rather than a carefully established fact based on comparison of its effects with and without other helpful measures. There is no doubt that the influence of climatic conditions is important in treating this, as well as other diseases, but it should always be made secondary to the intelligent handling of the patient. Favorable climate and intelligent medical guidance will offer best chances of cure.

Many important discussions of climate may be found in such monographs and papers as those of Solly,[1] Huggard,[2] Weber and

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[1] A Handbook of Medical Climatology, Lea and Febiger, Philadelphia, 1897.

[2] Handbook of Climatic Treatment, Macmillan Company, New York, 1906.

Hinsdale,[3] Huntington,[4] Sewell and Barlow,[5] N. Zunst, A. Loewy, Franz Muller, and W. Caspari,[6] and the Transactions of the American Clinical and Climatological Association.

While favorable climatic conditions are of value in the treatment of tuberculosis, climate, *per se,* that is, without other important and helpful measures, comes far down the list of curative measures in efficiency.

The writer has been treating tuberculosis in probably one of the most favored spots that could be found for a continuous habitation. The foothills of Southern California possess a moderately dry atmosphere. The mountains tower to the north and east to an elevation of from 5,000 to 11,000 feet. Beyond the mountains is a great desert waste, which is free from habitation. To the west and southwest, at a distance varying from twenty to sixty miles, lies the ocean. The proximity of the desert and the ocean creates conditions which are especially favorable for a pure atmosphere. The climate in this section is mild. Nearly every day is comfortable.

At Monrovia, the particular place where I have made my observations, we have rain on from fifteen to thirty days a year, the amount of rainfall ranging from five or six to thirty or more inches per year, most of which falls during two or three heavy storms.

The soil is of decomposed granite and porous, and even these heavy storms are unaccompanied by mud.

The winters are delightful, the temperature rarely reaching freezing, and in the valley below, it is only a few degrees colder.

The summers are comfortable and enjoyable. During the year we expect from fifteen to twenty-five days on which the thermometer will go above 90 degrees. On these hot days the humidity drops frequently as low as 10 or 15 per cent; and, no matter how hot the day, the nights are always refreshing. The nights are so pleasant that it is an exceptional year when blankets are not used every night. The great influence of this night tonic cannot be overestimated. These cool nights insure refreshing sleep and the patient awakens in the morning rejuvenated. Every night is a tonic cool air bath.

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[3] Climatology, Health Resorts and Mineral Springs, vols. iii and iv of A System of Physiologic Therapeutics, Edited by S. S. Cohen, P. Blakiston's Son & Company, Philadelphia, 1902.

[4] Civilization and Climate, Yale University Press, 1915.

[5] Tuberculosis, A Treatise by American Authors. Edited by A. C. Klebs, D. Appleton & Company, New York.

[6] Hohenclima und Bergwanderungen, Deutsche Verlagshaus, Bong & Company, Berlin, 1906.

This section is almost wholly free from sandstorms. These are usually generated by wind coming over the mountains, consequently the southern slope of the mountains is particularly sheltered from them. At the present time, sandstorms are not frequent like they formerly were, because of increased cultivation of the land and the paving of the roads.

The foothill section is particularly free from fogs. While an exceedingly heavy fog often lasts for many hours of the night and even part of the day near the ocean, it is exceptional to have all day fogs even at the coast. Very often when it does come in it does not reach this section until four or five o'clock in the morning and usually melts away before the sun about seven or eight o'clock in the morning. Occasionally, however, there is a continuous fog during the entire night, and, at times, we have a very heavy fog lasting the entire forenoon, but rarely extending through the whole day.

Patients live out of doors every day in the year with comfort. It is only those whose reacting power is exceedingly low, that suffer discomfort; but these suffer as little here as they would in any place that could be found. When properly guided, their reacting powers usually adjust themselves to surroundings and they become comfortable after a short time in the open air.

Another factor which adds greatly to the contentment and pleasure of those living in this section is the vegetation. The luxuriance of vegetation and the profusion of flowers in the winter and early spring, is a delight to all; and, at the various periods of the year we have orange blossoms, poppies, roses, carnations, violets, chrysanthemums, and numerous other flowers, which are not only beautiful to look at, but surcharge the atmosphere with their fragrance. The perpetual green of the citrus trees and other evergreens, which are indigenous to this section, add greatly to the landscape.

Surrounded by such climatic conditions it is easier for the patients to undergo the long confinement without restlessness, than it is in less favored spots; but open air can be employed elsewhere as well as here; guidance, food, rest, exercise, tuberculin, psychotherapy, and the various tonic measures which are applied here can all be applied elsewhere. While the discomfort and monotony to the patient would probably be greater in less favored localities, yet the result would not differ as much as might be supposed.

Man's Power of Physiological Adjustment.—One of the important things to understand in climatology is the power that man has for adjusting himself to his environment. Man's physiological mechanism is exceedingly adjustable. He can go from desert air to the sea coast, or from the lowlands to the high mountains, and, after a short time, adjust his physiological balance perfectly to the new conditions. It is on this adjustment that he must depend for adapting himself to different climates and different weather conditions. We do not find the identical physiological conditions in a moist climate that we do in a dry climate, nor in the lowlands that we do in high altitudes; but we can, with safety, rely upon man's ability to adjust his physiological equilibrium in such a way that he can live under all of these conditions with safety, and, for the most part, with comfort.

He can withstand and adjust himself to the cold of the northern winters and the heat of the southern summers; the dryness of the desert, and the dampness of those places receiving the greatest amount of precipitation; and still maintain his ability to meet such extraneous demands as are made upon him by disease. This is most fortunate for man's existence, because the great majority of human beings must fight disease in their home surroundings. It is comparatively few who can avail themselves of climatic change, particularly if such change requires a long journey. Where favorable climatic conditions can be added to other important measures, however, these will add to the patient's chances of cure just to the extent that they improve cell activity and the functional qualities of the various organs, and protect the patient from infections. While favorable climate is desirable, it is not essential.

Like that of all other measures in tuberculosis, the effect of climate is relative, and climatic change should be advised only when the patient can avail himself of other important measures, particularly that of intelligent medical guidance at the same time. With these preliminary remarks, let us take up some of the important factors in climate.

We have seen in our quotation from Hill in the chapter on "Open Air" that the principal factor which makes open air of greater importance than confined air is its physical effects upon the surface of the body. We likewise find that the factors which are particularly beneficial or harmful to tuberculous patients in the various climates depend upon the manner in which they influence the body physically, rather than the way in which they influence it chemically. It is not, as was formerly thought, the amount of oxygen or ozone, or carbon dioxide *per se* that is contained in the particular air of a community that makes it valuable or harmful; but it is the temperature, humidity, and movement of the air, the way in which it stimulates the surface of the body, and the way in which it influences and controls nervous discharge, that affects the patient beneficially or harmfully.

Man in civilized life is forced to live in a bad environment. This results from his adaptation to the demands of society. He was not intended to be a clothed animal. Of all the animals he is the only one that has artificially deprived his body of the free circulation of air. Intended to have a bare skin and withstand the elements, he has deprived himself of the stimulation which comes from cold and air movement, and wrapped himself in warm, thick clothing and shut himself up in confined spaces. The result is that the equilibrium which should exist between his body and his surroundings as a naked animal, exposed to various climatic conditions, is greatly disturbed. In spite of these unnatural conditions man is still an adaptive organism.

The influence of this adaptation is shown in many ways. It may be seen in the way in which the mucous membranes of the upper respiratory tract adjust themselves to the various climatic changes. When one goes from the lowlands to high altitudes, particularly if he goes from a moist climate, he suffers from discomfort in the upper respiratory tract, and, consequently, is very apt to say that he acquires a catarrh by the change. The individual going from high altitude to the lowlands likewise says that he suffers from catarrh in his new surroundings. The same thing is true in going from desert climates to moist climates, such as are found in the central west, and the eastern states; likewise in coming from the eastern states to the dry low climates of the desert regions. The cause of this disturbance is not only due to varying degrees of moisture; but it is a matter of changing the physiological balance, causing the mucous membranes to adjust themselves to new conditions of physical stimulation. The changes which take place in the blood in going from low to high altitude, and vice versa, must be looked upon in the same way. They are physiological. They are a part of man's ability to change his physiological balance in order to meet the varying demands at different degrees of altitude. Concentration of the blood and increased hemoglobin are changes made necessary for the physical comfort of the individual in order to meet the varying demands at different degrees of altitude. That they have any beneficial influence upon the healthy, or curative influence upon the ill, cannot be maintained, except as it comes from an extra and prolonged stimulation of the metabolic activities of the patient. If the organism has a greater concentration of blood, and an apparently or actual increase of hemoglobin, or other constituent elements of the blood at a high altitude, as compared with low altitude, it is a physiological change and must be looked upon as such. In support of this I quote from Cohnheim,[7] who shows that the concentration of the blood is a big factor in the changes which appear in the blood at an altitude as compared with lowland.

> "Another instance in which our sensations have probably given rise to scientific error and in which I have had some experience is the increase in the number of red blood corpuscles at high altitudes. It was first pointed out by French physiologists in 1883 and later thoroughly investigated by Miescher that at an altitude of 6,000 feet the number of red blood cells per cm. is 8,000,000, as compared with 5,000,000 at sea level. Such an increase suggests at once, as a probable explanation, an increase in the concentration of the blood, and this increased concentration does occur at an altitude of 5,000 feet or more. Abderhalden, studying rabbits and rats, has observed that the concentration of the blood is greater at St. Moritz, 6,000 feet in altitude, than in Basel, 700 feet, but that the absolute number of red blood corpuscles and amount of hemoglobin are not at all changed.
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> "As a result of work which I did last summer in the Monte Rosa laboratory, I am able to give some explanation for this increased concentration and for the marked differences in the results obtained by dif-

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[7] The Influence of Sensory Impressions on Scientific Deductions, The Harvey Lectures, J. B. Lippincott Company, Philadelphia, 1909.

ferent investigators. In high altitudes the air is dry and cold and the output of water through the surface of the lungs, which is a merely physical process, must be a great one. In addition, the water will vaporize more easily and more quickly because the barometric pressure is lower than at sea level.

"The loss of water by respiration at high altitudes is much greater than at sea level. We observed last summer at Heidelberg, which is practically at sea level, that a man loses 200 to 300 c.c. of water during a night's sleep, providing no loss occurs by perspiration through the skin. At 10,000 feet altitude he loses from 500 to 700 c.c. during the night; at 15,000 feet perhaps more, but other factors enter here. This loss of water increases the concentration of the blood and the number of red blood cells rises. But this holds true only for small animals, such as the rabbit, guinea pig, and hen. In these animals, according to mathematical calculation, the body surface compared to body weight is relatively great, greater than is the case in animals of large size, such as man or the horse. If the body produces heat by food combustion and muscular work the smaller animal can easily rid itself of this heat by means of its large surface; the larger animal finds difficulty in giving off excess of heat and it has therefore special arrangements for bringing about heat output. It vaporizes water and becomes cold through the coldness of vaporization. Dogs perspire by means of the lungs and the surface of the mouth and tongue; men and horses through the skin. The human body is adapted, therefore for the loss of water. If the body, and that means the blood surrounding the sweat glands, loses water, this water is replaced by that coming from water reservoirs in the muscle, probably in the connective tissue of the muscle. In the rat and rabbit such water reservoirs are absent or not developed, and so the loss of water produces concentration of the blood. In man, most of the loss of water is compensated and the concentration of the blood either does not rise, or it rises in small amount or the concentration may vary at short intervals.

"I ask now why these processes relatively so simple lay for such a long time in darkness. I think the reason is that most investigators have studied only the relations of gaseous exchange in the lungs and in the body, and the oxygen supply, and have tried to show that oxygen was deficient in both air and body. They did so because they knew that in high altitudes the respiration was difficult, that dyspnea occurred, but most of this dyspnea was produced by fatigue, by the hard work of climbing, unusual for physiologists coming directly from the laboratory. In an altitude of 15,000 feet it seems that the oxygen supply is not efficient, or at least not for all men, and the study of oxygen consumption is justified, but at 6000 feet and even at 10,000 feet no evidence is brought forward of the lack of oxygen, or the lack of carbonic acid, assumed by Mosso, and it is at these heights that the increase in red blood corpuscles has been most studied and is most evident. That most physiologists have tried to find a greater metabolism at these altitudes, and have tried to connect it with the increase in blood corpuscles and with the concentration of blood, can be explained easily by the sensation of difficult respiration. Their sensations have led them along a false way and have prevented them from pointing out the true reasons of the concentration."

Conclusions Drawn From Too Limited Observation.—If the great majority of men lived at a high altitude and they should become ill of tuberculosis or other chronic diseases, and should be sent from that altitude to a lower level, and should improve; and it should be found on laboratory examination that red corpuscles became less, hemoglobin decreased, and that there were certain changes in blood pressure, in the rapidity of the heart's action and in respiration, it would be quite probable that someone would draw the conclusion that the improved condition was due to these changes in the blood elements, and circulatory and respiratory mechanism, instead of interpreting them as evidence of physiological adaptation. We find that the body can, physiologically, within certain limits, adjust itself to cold, even severe cold; or heat, even a high degree of heat; humidity, either as applied to the atmosphere in general or to precipitation; dryness, applied to the atmosphere as a whole, or to lack of precipitation; to fogs, bright sunlight, cloudiness and all of the physical phenomena which make up our complex known as weather.

There are certain climatic conditions under which many patients are obliged to live, which are not as favorable as might be found in other localities; but the physician must determine whether the correction of the unfavorable conditions which seem to be present, is essential to the patient's recovery. Patients worry unnecessarily about climatic conditions and do themselves more harm by their worry than the unfavorable conditions in their climatic surroundings can possibly do them. I jokingly say to my patients, "Don't worry about weather. Worry about something that you can control."

The unfortunate thing about most discussions on climate, in its relation to the cure of tuberculosis, is that they are more or less intentionally, or unintentionally, partisan. One man has seen splendid results obtained in a given favored locality, and he draws the conclusion that it must be due to that particular locality. Another one has seen equally favorable results in a very different place under markedly changed climatic conditions. He likewise draws the conclusion that these results are due to the climatic conditions which prevail there. A third man, living under unfavorable climatic conditions, has seen good results follow a given routine and draws the conclusion that patients can get well in unfavorable climates just as well as they can in favorable ones. All are right and all are wrong. They are all right in the one observation that tuberculosis is a curable disease when the patient is intelligently guided, and that this intelligent direction may be carried out under various climatic conditions. They are equally wrong in drawing the conclusion that the cure which resulted was due alone, or largely, to the presence of favorable climatic elements, or that climate has no influence.

From the previous general discussion it can be seen that while climate is a complex, resulting from many factors, such as heat, cold, air movement, moisture, dryness, sunlight, and cloud, and that it is influenced by such things as large bodies of water, mountains, deserts, and vegetation, yet the good or bad influence of the climate depends on the degree to which a man can adapt himself to the particular elements present, and maintain a physiological equilibrium. There is no individual element which goes to make up the particular salubriousness of the climate of any particular place that is essential to the health and life of anyone; neither is there any one element that is absolutely harmful.

Ozone.—For centuries pine forests have been thought to have a remedial influence on diseases, particularly those of the respiratory tract. This was thought to be due to the fact that there was more ozone in the air of such forests than in forests in general. We now believe, however, that it is not due to any particular chemical property of the air in the forests; but to the fact that as the wind blows through the trees it becomes purified, much as water becomes purified by running in the stream. Certain injurious gases are removed and it is freed from dust particles and bacteria. It has also been shown that bacteria do not grow as well in forests as they do elsewhere. The curative value of ozone, however, is not established.

While it is well known that plants take up large quantities of carbon dioxide from the air, and liberate oxygen, yet these changes make so little difference in the oxygen or carbon dioxide content that they are questionable as factors of importance in therapy. Both of these constituents of the air show very little variation as is shown in the table in the previous chapter, quoted from Hill.

In discussing the question of oxygen, with reference to the air, Hinsdale,[8] says:

"The occurrence of ozone in the air of forests, especially coniferous forests has been credited, since its discovery by Schoenbein in 1840, with affording remarkable health-giving qualities. This opinion has become firmly fixed in the minds of the public, and to a large extent, has been accepted by the medical profession as an evidence of high oxidizing power at once corrective of decaying vegetation and exhilarating and curative to mankind. * * *

"It has been found that the air immediately above the tree tops and at the margin of the forests is richer in ozone than that of the interior, where a portion of it is utilized by the decaying vegetation. Ozone certainly aids in purifying the air by oxidizing animal or vegetable matter in process of decay, and by uniting with the gases produced by their decomposition. It can, therefore, be found in considerable amounts where the air is particularly pure. This amount rarely exceeds one part in 10,000."

The supposed beneficial effect of ozone on tuberculosis is based on wrong conclusions. It is based on the supposed fact that the factor in the air which cures tuberculosis is oxygen and that oxygen in the form of ozone is more valuable than oxygen itself. We cannot accept the fact that ozone has any particular influence in the cure of tuberculosis. If so, it must be a very small one. It is not consistent with our ideas of the process of cure in this disease. Oxygen generators have been very commonly used by laymen and physicians in the treatment of tuberculosis, their employment being based upon the supposed value of ozone.

The greatest factor in the forests in the treatment of tuberculosis is probably the mental effect. There is a certain degree of pleasure to be derived from living in proximity to forests. They stimulate one to be out of doors and attract one to the out-of-door life. I would consider this an important factor in the open air treatment of tuberculosis.

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[8] Atmospheric Air in Relation to Tuberculosis, Smithsonian Miscellaneous Collection, 1914, vol. lxiii, No. 1.

The use of the forest reserves of the various states for the treatment of the tuberculous as it is carried out particularly in Pennsylvania, is commendable. It is using public property for the benefit of society at large by curing disease, taking away the danger of infection, and increasing the general resistance of those who are given its benefits.

City Air Versus Country Air.—It is obvious to anyone that the country is a much better place to treat tuberculosis than the city. This difference does not depend on the relatively greater amount of oxygen and lessened amount of carbon dioxide in the country. It does depend somewhat on the bacterial content of the air; the pollution of the city air being many times as great as that of the country air, thus increasing the relative danger to the city dweller from bacterial disease. It can be observed that the transmission of acute respiratory diseases, and such other infections as are apt to complicate tuberculosis, take place easier in the city than in the country.

Soot and smoke are more prevalent in the city. What the detrimental effect of smoke on the tuberculous patient is we do not know. The inhalation of carbon among coal miners does not seem to increase the tendency to tuberculosis; in fact, it is commonly stated that there is less tuberculosis among coal miners than those in other occupations. Whether or not there is an accurate basis for this statement we do not know.

The city air contains a great deal of dust, much more than the country districts, except those in very dusty regions.

Aside from the physical elements just mentioned, there are many gaseous elements which are particularly prevalent in the city air that may be more or less harmful to the respiratory mucous membranes. The probabilities are, however, that the difference between city and country life in its effect upon the tuberculous, as well as the non-tuberculous, is not wholly due to impurities and bacterial contamination of the air. Diminished air movement in the cities as compared with the country; the nervous excitation and irritation that comes from the noise of the city; its hustle and bustle; the constant association with many human beings; the temptation to be a part of the crowd and take part in their activities, which, if repressed, or yielded to in either case has a tendency to detract the patient's mind from a carefully devised regime, and dissipate his energies, are all important factors.

In discussing the variability of oxygen and carbon dioxide contained in the air, Hinsdale,[9] says:

"The Boston Nutrition Laboratory of the Carnegie Institution of Washington has undertaken a most painstaking series of investigations bearing on this subject. They include an examination of the comparative oxygen-content of uncontaminated outdoor air under all conditions as to wind direction and strength, temperature, cloud formation, barometer, and weather. In addition samples of air were collected on the Atlantic Ocean, on the top of Pike's Peak, in the crowded streets of Boston, and in the New York and Boston subways. The results of the analyses of uncontaminated outdoor air showed no material fluctuation in oxygen percentage in observations extending over many months and in spite of all possible alterations in weather and vegetative conditions. The average figures are 0.031 per cent of carbon dioxide and 20.938 per cent oxygen. The ocean air and that from Pike's Peak gave essentially similar results.

"The extraordinary rapidity with which the local variations in the composition of the air are equalized is accentuated by the observations on street air in the heart of the city, where the contaminating factors might be expected to be of sufficient magnitude to affect perceptibly the analytic data. Only the slightest trace of oxygen deficit is shown, with a minute corresponding carbon dioxide increment. Observations such as these tend to demonstrate the extent of the diffusion of gases and the establishment of equilibrium by air-currents.

"Most unexpected are the figures in regard to the extremely small extent to which the air was vitiated in the modern 'tube' or subway, even during the 'rush' hours. There was, on the average, a fall of 0.03 per cent in oxygen accompanied by a rise of 0.032 per cent in the carbon dioxide."

Sea Air.—Sea air has long been supposed to have particularly curative effects in tuberculosis. Long sea voyages were recommended and many striking results reported. This particular value of sea voyages was undoubtedly based on a faulty conclusion. Many patients in the earlier course of this disease, when the symptoms are slight, will improve by any measure, providing it makes sufficient impression upon the body cells, as a whole, or upon some particular group of body cells, to increase the resisting power of the patient to such an extent that it overbalances the aggressive action of the invading bacilli. In many cases a simple change of occupation, or a visit to the country, or some good tonic, is sufficient to turn the tide in favor of the individual. Many of these patients who were reported to be cured by sea voyages could doubtless have been cured by a rest from work, or change of environment at home; but, because they received their benefit while taking a sea voyage, this particular measure was accredited with curative action.

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[9] Loc. cit.

We must not get away from the fact that any measure, or any set of measures which will raise the resisting power of the patient to such an extent that it can overcome the aggressive action of the bacilli, may be the determining factor in cure; but, it would be foolish to think that there is any specific efficacy in the measure used that could not be obtained by any other measure, or measures which alone, or combined, would make an equal impression on the cellular activity of the patient.

There has been far too much reasoning of this character for the good of the tuberculous patient. There are many drawbacks to ocean voyages; and, in fact, today we can hardly recommend them at all. During the time of the sailing vessel the voyage occupied sufficient time to give the patient a complete rest, and the stimulating effect of the sea air over a long period of time; but now, with rapid travel, comparatively little good can be obtained, and the good which might come from sea voyages is more or less overbalanced by the injurious factors associated with the voyage.

Sea air may be obtained, however, along our coast and on the islands in the sea. Those not too far from the mainland might be used advantageously. The air in such localities is usually comparatively free from contamination; and, as a rule, the movement of the air is such that there is a marked stimulation of the body functions associated with increased metabolic change.

That there is any particular advantage in breathing salt laden air is open to question. If the patient can secure the rest and quiet at the seaside that he can secure elsewhere, there is no reason why he should not obtain a marked stimulation of the body cells, which might greatly aid him in recovery.

Fog is very commonly found at the seashore and also over the ocean itself. It is generally believed that fog is very harmful to tuberculous patients. This statement is entirely too general. I can see no reason why fog should be any more detrimental to a patient suffering from early pulmonary tuberculosis than it is to the individual who is free from tuberculosis. The patient suffering from advanced tuberculosis who has considerable associated bronchitis will, as a rule, cough more on account of fog. Fog is also inclined to produce chill; but, against this the patient can easily guard himself by proper clothing and by hardening himself against cold. Foggy air is cold and chill producing, and usually unaccompanied by wind, so its effect is that of a damp cold, without the stimulation necessary to quicken metabolic change.

At the present time the popularity of the seaside for sanatoria for children is increasing. Many draw the conclusion that the beneficial effects noted at these maritime sanatoria are due to salt air, but they most likely depend upon the physical stimulation exerted upon the surface of the body, and the happiness and contentment induced by the surroundings.

These children, for the most part, are taken from the crowded cities. They are children who are poorly nourished, who have been shut up in closed rooms and wrapped in clothing, children whose general vitality is below normal, and who have been struggling against vicious environment. They are placed in pleasing, favorable environment; surrounded by a stimulating atmosphere, which, acting through its influence on the nerves of the skin, favorably affects every important organ of the body, increasing metabolism and improving general nutrition. They are intelligently supervised and cared for by attendants who are interested and capable of giving them the intelligent guidance which they need. The beneficial effects are not due to any one element, but to many influences which act through physical and psychical impressions.

The French have established numerous sanatoria for children along their coasts. Some very interesting and valuable work has been done in this country by Doctor William H. Bennett of Philadelphia, who established the Children's Sea Shore House at Atlantic City, and Dr. John Winters Brannan of New York, who established "Sea Breeze." Doctor James Alexander Miller, cooperating with the school authorities, devised a practical means of giving some of the children of the thickly populated districts near Bellevue an opportunity to go to school; and, at the same time, have the benefit accruing from sea air, by the use of discarded ferry boats. Thus, the children have the benefit of the open air on the river and also an opportunity to study and carry on their school work at the same time.

Inland Climates.—The climate of any extensive country must, of necessity, be variable, because it is influenced by such factors as latitude, longitude, mountains, seas, physical contour and vegetation. From the standpoint of their effect on the human organism, consequently their therapeutic value in tuberculosis, we might make many divisions of climates; but their particular favorable and unfavorable influences may be illustrated in the following types: Moist lowland climates, dry lowland and arid climates; and mountainous climates. Climatic influences are wrought largely by the impact of the air upon the body surfaces. This impact, or stimulation, varies according to the temperature and the degree of moisture present in the atmosphere, and most of all, according to the degree of air movement present. These variable factors may be combined in almost endless ways, each changing the result to a certain extent; but it will be unnecessary to go into these matters deeply in this discussion. Suffice it to say that a cold atmosphere and a dry atmosphere, either cold or warm, if accompanied by wind, are stimulating. Hot moist atmospheres and hot dry atmospheres without wind movement, on the other hand, are enervating.

The amount of stimulation that is produced depends considerably upon the air movement, as will be readily understood. If an atmosphere is dry, but its temperature lower than the body and the degree of air movement marked, it produces considerable stimulation. The colder the atmosphere and the more rapid the wind movement, the greater the heat abstraction. Cold, moist atmospheres, without wind, chill but do not stimulate sufficient metabolic activity to make up heat requirements. The physical impact of the air upon the skin and the resultant heat abstraction furnish a strong stimulation for metabolic activities.

Bearing these factors in mind one can see that all lowlands cannot be classed together, although they are commonly so discussed. Different lowland climates differ as much as those of the lowlands and mountains. In the United States the great lowlands of the Mississippi Valley and of the eastern coast, have a moist climate. The summers are warm and the winters are cold. The climatic conditions further north and further toward the Rocky Mountains are drier both in winter and in summer. The atmosphere of the great arid regions of the west and southwest is dry throughout the year. In these regions the winters are quite cool; and, in most of them, unless they be near the coast, the summers are warm, and in the interior they are hot. Being dry, the air does not retain heat well, consequently there is a wide diurnal variation between day and night; and, while the days are warm, the nights are cool. In some of the desert regions, however, the heat of the day is such that the earth's surface does not cool off during the night, and, in spite of a low humidity, the nights are warm. These conditions are found in many localities in the interior, in the middle of summer. In all localities where the earth's surface cools sufficiently to permit of wide diurnal variation, the climatic conditions are stimulating during the entire year, at least, during that portion of the day when the sun is not shining. The difference between these two types of lowland climates is evident. Damp, warm summers and cool, damp winters prevail in the Mississippi Valley and other eastern sections, which are thickly populated and contain the bulk of the population of our country. The western lowlands are sparsely inhabited and almost free from any deleterious effect that comes from civilization. Indigenous tuberculosis is prominent in the former localities; it is rare in the latter.

The conclusion must not be drawn, however, that it is at all indicative that the lack of indigenous tuberculosis in the southwest is due to an immunity from the disease. There are several factors present in arid regions, in common with those in high altitudes, which make infection less prevalent. The first, and probably most important one, is the lack of population. Tuberculosis is a disease which follows crowded conditions. Infection depends upon intimate association which rarely occurs in sparsely settled districts. The moist climates, with a small percentage of sunshine, favor the life of bacilli after they have been cast out from the tuberculous subject. In the arid lowlands and in the mountainous regions the atmosphere is drier and the light much brighter; the diathermacy of the atmosphere is greater; the percentage of sunshine is high, consequently bacteria are quickly destroyed when cast from the body, and the spread of infection is thus prevented. These dry lowland climates, in common with dry mountain climates, have certain direct effects upon the tuberculous patient that are more or less beneficial. The action of the sunlight and the air currents in these sections is stimulating to metabolism (see chapter on Heliotherapy), the stimulation being much greater in the mountains than in the arid lowlands as a rule. The absence of population with its harmful environmental influences is a big factor. The opportunity for contamination with other bacteria is not so great. The harm that comes from associating with people in thickly populated sections is eliminated and the patient is shielded from many deleterious influences.

While dry air may be obtained in the arid regions and in the mountains, and relatively dry air may be obtained in many of the sections east of the Rocky Mountains, yet the peculiar climatic conditions present in the mountainous regions, taken as a whole, give us our most stimulating effects. The dry arid regions furnish a stimulating climate in winter, during all parts of the day, and those parts where the summer nights are cool, furnish stimulating conditions even during the hottest weather, and are not enervating like the moist heat found in the eastern sections of our country, because in winter the climate is stimulating during all hours of the day, and in summer during all but the hottest period, and often during it.

The mountainous countries have particularly to their credit a greater diathermacy than even the arid regions of the lowlands. They also have a dry atmosphere and a rapid movement of air. All of these elements are distinctly stimulating. They, at times, become the same as they do in arid regions, though to much greater degree, too stimulating, and react upon the nervous system, making the patient irritable. This effect is often seen, particularly in women who live at high altitude over a prolonged period of time.

It is doubtful whether the changes in the blood and blood pressure which are noted at the high altitude *per se* have any beneficial curative effects in tuberculosis, or any effects upon the healthy which would particularly improve his general condition. Owing to lessened atmospheric pressure, physiological changes must take place in man as he goes to a greater elevation that the individual may live and carry on his vital functions to advantage; thus, the concentration of blood resulting in an apparent increase in red cells, the increase in hemoglobin, the change in blood pressure, the enlargement of the thoracic cavity, and the changes in respiration and heart beat are all physiological and must be looked upon in this way, the same as the increased tan which is deposited on the surface of the skin of those people who are exposed to either mountain or arid sun. The changes in the blood are made necessary by the decreased pressure. Tanning of the skin in regions where the sunshine is bright is necessary to protect the individual from too great light penetration.

Cold Air Versus Warm Air.—It will be recalled that in the discussion of the factors in air which are particularly favorable or unfavorable to metabolic changes, that the physical effect was particularly emphasized. Much of the effect of air upon the body is brought about through the stimulation of the cells and nerve endings of the skin; much of it by the property possessed by the layer of air covering the skin to decrease or increase the abstraction of heat from the body.

It can be readily seen that there should be great variability in the effect produced by air of different temperatures. The colder the air, providing it is in motion, the greater the amount of stimulation to the body surface, the greater the heat abstraction and the greater the demands upon the individual's body for restoring lost energy. This demand is met by increased appetite, and improved digestive capabilities, and requires an increase in the intake of food.

Therapy goes by fads. Too often general conclusions are drawn from limited observation. It has been noticed that individuals will consume more food and put on more weight in most localities in the winter than they do in the summer. The conclusion has been drawn that, on account of this, winter is the best time for the treatment of tuberculosis; and, further that cold air is more advantageous than warm air in the treatment of this disease. If the cure of the patient depended on the amount of food consumed, and the amount of weight put on, this might prove true, but it does not. It is evident that cold increases the metabolic changes in the body cells and calls upon the individual to consume more food to meet the extra demands. It further attempts to make this possible by increasing the appetite and digestive capabilities. If the patient's reactive powers are sufficient, he responds and feels no ill effects from the cold. Most individuals possess a power of physiological adaptation which enables them to meet reasonable demands of this nature; but, if unable to meet the requirements, harm will result. The tuberculous patient must not only meet the demands which would be made upon him as an individual, but also must have reserve energy left to use in fighting his disease. If the demands made are not too great he may do both. He may benefit from the cold and the extra stimulation of his vital powers caused by it. If, on the other hand, he is unable to measure up and furnish the extra energy required, the cold will result in harm.

Thus it may be clearly seen that cold may be of value if it stimulates metabolic change to such a degree that the patient is able to counteract its effects and still have extra energy left. We may also see that the effects will differ with the patient's reacting powers. It is not the cold, regardless of degree, that proves beneficial, but the amount that will stimulate the patient's cellular activity to overcome it and still have reserve energy stored up to increase his resistance to the disease. One individual might profit, while another might suffer harm as a result of an exposure to a low temperature. A patient with early tuberculosis might be able to react and endure severe cold, when the same patient, after suffering harm to his cellular activity and reactivity as a result of chronic tuberculosis, might not be able to respond to the stimulation to a degree sufficient to meet the extra demands, and so would suffer harm.

We must not lose sight of the fact that the bodily changes which take place in winter, as compared with summer; in high altitudes, as compared with lowlands; and between moist climates as compared with dry climates are *per se* proof of the ability of man to adapt himself physiologically to different environments, and physiological demands rather than evidence of increase in body resistance.

I have tried through twenty years of observation to determine the seasonal influence upon patients. There are so many other factors that come in, however, aside from those which are distinctly climatic, that it is extremely difficult to draw conclusions.

We note, here in Southern California, that our patients put on more weight when the weather is cool than they do when the weather is warm, the same as is noted in the colder climates of the east and north. I look upon this as being due to two things: first, cold air requires a more active metabolism on the part of the body cells in order to keep up body heat than warm air does; second, a layer of fat covering the body has a very marked influence in protecting the individual against cold, consequently it is natural to increase fat in the winter. That this increase of fat which is made necessary by the cold is any indication of an increase in the patient's ability to fight disease, will bear close scrutiny before acceptance. Every farmer knows that it is a matter of economy to shelter his animals in cold weather; the animals living in the warm shed will not require as much food as those living in the open. This does not signify that the animal exposed to the cold is any healthier than the one protected.

Huggard[10] quotes Amsbury[11] as showing that observations made at the Kansas Agricultural College demonstrated the fact that swine kept in the open air during rather severe weather require 25 per cent more corn to make a given gain than those which are sheltered.

Huggard also mentions the fact that persons going from the comparatively mild climate of England to the cold climate of Davos, in winter, frequently lose weight at first, and those who gain weight in the beginning require much more food than they do at their home; and that persons going down from Davos in spring, to the warmer lowlands, put on weight. This latter fact is probably due to the complete change of climate and environment associated with the change, which is very prone to improve nutrition. It is a constant observation that patients making changes in climate, even although conditions may not be so favorable in the new place, notice an improvement in appetite, and a gain in weight, at least for a time, because of factors other than climatic.

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[10] Handbook of Climatic Treatment, Macmillan Company, New York, 1906.

[11] Principles of Animal Nutrition, 1903.

In considering the effect of any particular climate, one must bear in mind that while each particular type has a more or less definite action upon the metabolic activities of the individual, yet many factors other than climatic, are to be considered. For example, the observation quoted by Huggard, that patients leaving the stimulating cold of Davos often gain after going to the lowlands, cannot be accounted for by the fact that the climatic conditions in the lowlands *per se* have a greater tendency than those of Davos to stimulate the functional activities of the body cells, with a resultant increase of appetite and digestive capabilities. They must be due to other factors. Cellular activity is greatly stimulated by the impressions gained through our various senses and also by the mental attitude which the individual assumes as a result of his nerve impressions; consequently, the stimulation of changed surroundings, the joy of getting home, the pleasure of seeing new objects, and old friends may improve metabolism more than the natural climatic stimulation which had existed at Davos. In this connection, however, we must not lose sight of the fact that the gain in weight also referred to may be a result of the persistence of increased functional activity which was produced by the climatic stimulation at Davos in the presence of lessened bodily demands. The appetite is increased, as a rule, by any stimulating climate, whether it be cold, either moist or dry, or warm and dry. Warm moist climates are debilitating; and, as a rule, do not stimulate the body to the same degree as the dry and cold moist climates; but the demands upon the body are not so great, consequently, less food is required. Any climate that increases metabolic change stimulates the appetite because larger quantities of food are necessary in order to keep up the physiological balance. This matter can be readily understood when we recall that most of the food consumed is used for the purpose of keeping up the heat of the body.

The foothills of Southern California present many different climates. Those near the ocean present a cool damp climate during the entire year. As we go back from the coast we have a dry cool climate from November until June and during the nights of the entire year; and a dry warm day climate from June until November. Now and then the usual climatic conditions are varied by the injection of three or four days of weather which is much warmer than usual. The length of these periods is occasionally doubled or tripled, but rarely so.

The effect of these temperature changes upon the appetite of the patient is very interesting. During a warm spell the demands upon the patient are very much reduced, metabolic changes are less active, consequently the patient's appetite diminishes and the body demands are met by a much smaller intake of food. If the heat was continuous over a prolonged period of time there might be a reduction in the patient's weight. These warm periods are, as a rule, of short duration, and are followed at once by normal nutritional demands, the appetite returning to keep up the physiological balance. If these spells are accompanied by moderate humidity, or absence of wind, as they are occasionally, then the maximum body temperature increases beyond what it has been during the colder weather.

The effect of these atmospheric temperature changes upon the body temperature is interesting. If the atmospheric temperature is high and there is an absence of wind, there will be an increase in the body temperature in a very large percentage of patients. If the moisture drops markedly, as it usually does, this increase in temperature is not as great as it is if the humidity is higher. If, on the other hand, the increase in atmospheric temperature is accompanied by wind, then the temperature of the body will not go so high. It will go higher, if the humidity is high, than it will if it is low. With the air temperature lower than the body temperature, if the air is allowed to circulate freely about the individual's skin and there is a wind with fair velocity, there will not be much rise in the body temperature produced by the rise in atmospheric temperature. The reverse of this is seen when a warm spell is followed by a sudden drop in atmospheric temperature. The body temperature drops below that which is usual.

These changes are not only noted in tuberculous patients, but in others,—even those in health. It takes a certain time for the heat regulating mechanism to adjust itself. The vasomotor system, which largely controls the diffusion of heat, is not as well regulated, in the tuberculous patient as it is in the normal individual, consequently his heat balance is not adjusted so quickly. After the weather has changed, either to hot or cold, and remains so for two or three days, the heat regulation is adjusted and the usual normal is established.

CHAPTER XXXVIII.

REST AND EXERCISE.

The subject of rest and exercise as therapeutic measures in tuberculosis must be approached from a strictly individual standpoint. While certain principles may be laid down, calling for a more or less definite routine, yet the amount of rest and exercise must be adapted to conditions present in each particular patient, always bearing in mind the physiological principles which underly them.

This subject is one of great importance. In tuberculosis we are endeavoring to build up and increase resisting power beyond that necessary to meet the ordinary demands of life; to store up such a degree of energy that the patient may be able to supply his usual body needs and still have energy remaining for fighting his infection. While we recognize that a certain amount of exercise is best for the general cellular metabolism, yet there are times in tuberculosis when exercise cannot be indulged in, except to the patient's detriment. There are times when the body cells are being poisoned by toxins, when the tissues are being broken down, during which all possible conservative forces must be mustered to prevent an undue and dangerous diminution in the constructive and defensive forces of the body. If, at such times, the body is subjected to exercise, the result can only be an extra and often too great demand upon the patient's vital powers. Whenever there is a question whether the patient should rest or exercise, it is safest to advise rest. Rest can do the least harm and is more apt to be attended by good.

In order to obtain an intelligent idea of the relative value of rest and exercise, it is essential that we have some understanding of the physiology of these measures, particularly of muscular movement.

The Physiology of Exercise.—Every action in the body is accompanied by increased metabolic change and all actions are accompanied by heat, except that of nerve discharge. As a result of muscular movement, there is a rise of blood pressure, an acceleration of the pulse, a quickening of the circulation, and an increase of respiratory effort. The following table, by Pembrey and Todd from Starling[1] shows the effect of exercise on the pulse rate and systolic blood pressure in trained and untrained individuals.

	A. B. (Trained)			A. H. T. (Untrained)		
	Rest	Just After Exercise	5 Min. Later	Rest	Just After Exercise	5 Min. Later
1. B. P. mm. Hg	110	134	118	104	134	108
Pulse ¼ min	13	28	14	18	27	24
2. B. P. mm. Hg	122	134	126	110	140	106
Pulse ¼ min	16	29	17	23	30	26

This effect upon the circulatory and respiratory systems indicates that muscular work is a powerful stimulant of cellular activity. This is also indicated by the fact that muscular exercise is attended by an increased production of heat, showing increased chemical action. When the muscles are called upon to perform work, they require extra motor power, which is supplied by the blood. The amount varies according to the strenuousness of the work accomplished. The muscular effort used in arising from the recumbent position and starting to walk calls for about four times as much oxygen as is used during rest. It is necessary for the muscles to be supplied with from four to six times as much blood during exercise as is required at rest.

In order to supply this extra oxygen and blood, the great splanchnic reservoir is called upon. There is first: contraction of the splanchnic vessels; second: under normal conditions, an increased inspiratory effort delivering more blood to the right heart; third: increased action upon the part of the heart itself; fourth: a forcing of the blood from the veins toward the heart by the increased tone of the skeletal muscles. The increased inspiratory effort is not only for the purpose of aiding circulation, but it is particularly for the purpose of oxygenating blood. Muscular action produces large quantities of CO_2, and if sufficient oxygen is not at hand, lactic acid is formed instead.

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[1] Principles of Human Physiology, Second Edition, Lea and Febiger, Philadelphia, 1915, p. 1006.

The amount of oxygen necessary for maintaining the body during rest and exercise is shown, in grams, in the following table of respiratory exchanges, taken from Starling:[2]

CONDITION	CO_2 ELIMINATED PER MINUTE	OXYGEN ABSORBED PER MINUTE	RESPIRATORY QUOTIENT	PULSE RATE	RATE
Lying	200	243	.83	56	20
Moderate Work	1720	1834	.94	150	32
Severe Work	2227	3265	.98	166	38

Not only is more blood and more oxygen required by the increased muscular effort, but a greater amount of food must be eaten to furnish the carbon for oxidation. Carbohydrates have been shown to be the chief source of this energy.

The following table from Starling[3] shows the total amount of energy, in calories, required per day in experiments during rest and work. This table also shows the relative amount of heat which is given off by radiation and conduction, in urine and feces, and in water vaporized from the lungs and skin. Heat energy is made by oxidizing the carbon of the food. As a result of muscular work from two to three times as much carbon is used as when

ENERGY PER DAY

NATURE OF EXPERIMENT	HEAT ELIMINATED			EXTERNAL WORK IN CALORIES	TOTAL IN CALORIES
	By radiation and conduction	In urine and feces	In water vaporised from lungs and skin		
Rest with food (average of four days)	1850	26	521	. .	2397
Rest fasting (four experiments) (average of five days)	1605	21	561	. .	2187
Work (fourteen experiments) (average of forty-six days)	3802	29	743	546	5120

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[2] Ibid., p. 640.
[3] Ibid., p. 639.

the muscles are at rest. From this it will be seen that much greater quantities of food must be eaten during exercise than during rest, and that the digestive capabilities of the patient must be taken into consideration when exercise is to be prescribed.

Cohnheim[4] discusses this point as follows:

''We know today that the reaction of tissue, blood, and lymph is almost strictly neutral and that the human body is provided with a number of means to maintain this neutral reaction which seems to be necessary for the normal function of most enzymes. During metabolism, acids are formed in considerable amount; bases, to a small extent. In muscular work which passes beyond physiological limits and demands greater supply of oxygen than is furnished, there is formed lactic acid and it seems, according to Zuntz, that the resulting fatigue is due to the formation of organic acids. Fatigue upsets the equilibrium of the reaction of the blood and tissues toward the acid side and every process, therefore, which tends to lessen acidity must be helpful in removing fatigue. In the stomach hydrochloric acid is formed from the neutral blood from which it withdraws acid ions, and this process tends to move the equilibrium toward the alkaline side. For this reason gastric secretion may be preventative of fatigue or the feeling of fatigue. Those substances which incite gastric secretion must also lessen or remove fatigue, and I believe that this assumption is what led Liebig to the idea that meat extract gives more strength and vigor to the body. Now we know that the fuel value of meat extract is very small, but yet we recommend it because it improves digestion, even though the appetite is lacking, and lessens the feeling of fatigue.''

It can be seen from these physiological principles that exercise calls into activity all the various functions of the body. It calls for more food and better digestion. It quickens the circulation. It increases respiratory effort and promotes general metabolic activities. In doing this it throws an extra burden upon the body cells, which is valuable, providing the organism is able to stand it. Exercise is a very valuable stimulant to nutrition and metabolism; but, if the body is unable to furnish this extra energy required, in order to carry on the extra activities, it will suffer. From the fact that it produces heat and increases metabolic change, it is evident that it is contraindicated in fever.

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[4] The Influence of Sensory Impressions on Scientific Deductions, The Harvey Lectures, J. B. Lippincott Company, Philadelphia, 1909-10.

If sufficient oxygen is not furnished, as is the case at times where the muscular effort is extreme; or in cases where the effort is not so great but for other reasons there is a failure to supply oxygen in sufficient quantities, then lactic acid, an intermediary product of combustion when CO_2 is produced, is formed and retained in the muscles. The result is a decreased alkalinity of the blood.

The importance of mental activity and nerve action must also be understood. It is but necessary to call attention to the fact that every cell of the body, consequently every activity, is presided over by nerve control; consequently, if there is a disturbance in the nerve cells, the functions of the various organs will suffer. A person may be physiologically at rest as far as muscular exercise is concerned, and yet be at the height of exertion from the standpoint of nerve action.

In the discussion of rest and exercise we must not lose sight of the fact that thought and nerve action has no less important a place than physical exertion in our therapeutic consideration, as will be discussed more fully elsewhere in this monograph.

The Physiology of Rest.—The importance of rest may be understood when we recall that man spends about one-third of each day under conditions of physiological rest. To be sure, there is never a time when some activity is not carried on, but during sleep only such acts are performed as are necessary to maintain life. Physiological sleep is ideal rest. It is a time when mental activities cease; when sensory impressions and muscular activities, except such as are necessary for the preservation of life, are inhibited; consequently, there is the least possible call upon the organism for energy. While it is impossible to continue such absolute rest during the entire twenty-four hours, yet there are conditions met with in many diseases, particularly in the one under discussion, when it is desirable to maintain as complete rest as possible. Not only does rest save the body cells from the expenditure of energy, but it also affords an opportunity for repair. When the body is at rest there is an opportunity not only to supply the needs of the limited cellular activity, which must necessarily go on, but to have a surplus remaining which can go to repair loss or to provide an excess of energy for future activity. There are times in such diseases as tuberculosis when rest becomes essential. It has been shown experimentally that overexertion in tuberculosis causes a lessened resisting power; and it is the experience of every physician who has treated many cases of this disease that overexertion lowers vitality and permits an increase of bacillary activity. Many cases of clinical activity date from physical overexertion.

Rest and Exercise as Therapeutic Measures.—While clinicians from time immemorial have suggested different degrees of rest and exercise in the treatment of tuberculosis, the first successful attempt to standardize exercise as a therapeutic measure was made by Brehmer, the founder of sanatorium methods. While Brehmer based the requirements of exercise upon a condition probably impossible of attainment, yet his experiment in the application of exercise is one that shows very keen observation. Contrary to the plan which has been instituted by so many of his supposed followers, his application of exercise depended upon a careful estimation of the individual's requirements and capabilities. He was convinced that tuberculosis was due to a small heart and, as a result of the small heart, the lungs were improperly nourished; consequently, he hoped to obtain a better nutrition of the pulmonary parenchyma by forcing more blood through the lungs. To this end, he prescribed exercise, hoping to increase the size and power of the heart. Many of his followers, however, understood his teaching to mean nothing more than that exercise was a cure for tuberculosis. Dettweiler, his famous pupil, noticed that some patients were harmed by exercise, no matter how carefully it was prescribed; and, after noting the good effects of rest, went to the other extreme, and established the principle of rest as a therapeutic measure. Dettweiler's personality was so strong that he started a reaction against exercise, and the theory of rest became the essential in the treatment of tuberculosis. For many years the pendulum has swung back and forth, and finally we are able to suggest as a safe and sane principle, that both rest and exercise are of value in the treatment of tuberculosis, but that each must be adapted to the requirements and capabilities of the individual patient, bearing in mind both the patient as an individual and the condition of the disease.

Rest should be prescribed whenever the patient is unable to exercise and, at the same time, store up energy for fighting his infection. Exercise, on the other hand, may be advantageously employed when the demands made upon the organism by it may be supplied without reducing the powers of defense which the patient needs for overcoming his infection.

Dettweiler's teachings are more generally followed and have exerted a greater influence upon the therapeutics of tuberculosis than those of Brehmer, partly because of a failure to study the demands of each patient, as far as exercise is concerned. It requires close attention to minutiæ to adapt exercise to the requirements of each individual.

There comes a time in every case progressing toward improvement and arrestment when exercise is best no matter if absolute rest has been necessary in the beginning of treatment. A physiological equilibrium is best maintained in the body under a certain amount of exercise. While rest is essential to life, in that it is necessary for the restoration of cellular waste, exercise is essential to the highest state of health and the best enjoyment of life. Therefore, where there are no contraindications, exercise should be a part of the daily life of every individual; for by it his cells will be stimulated, his organs will functionate better, and he will be a stronger and healthier man.

There are certain conditions that arise during the course of pulmonary tuberculosis under which rest is essential, and must be employed in the best interest of the patient; likewise there are times when exercise is equally advantageous. The discussion of these various conditions, as we proceed, is bound to overlap to a certain degree; and further, the impossibility of arranging their discussion in a perfectly logical order will be apparent.

Prior to entering upon the discussion of rest and exercise, it is necessary to make clear that we are discussing clinical tuberculosis. The old term "incipient tuberculosis" has no place in modern medicine because we now know that "incipient tuberculosis" is a misnomer. Incipient tuberculosis is that form of glandular tuberculosis which is usually symptomless (or if symptoms are present they remain unrecognized) and which is associated with the primary infection, and is confined, for the most part, to the years of childhood. Clinical tuberculosis, on the other hand, is tuberculosis that produces recognizable clinical symptoms, and, in my discussion of rest and exercise, this form will be understood.

Rest and Exercise in Early Afebrile Tuberculosis.—Tuberculosis may be active and still be unaccompanied by pronounced symptoms. In many cases there is a long period during the extension and development of the disease when bacteria are multiplying and extending to new tissue and yet few or no recognizable symptoms are present. We are not justified in assuming that this period is free from the production and absorption of toxins. It is much more probable that the tolerance of the patient's cells is raised to such a degree that large quantities of toxins may be present without producing recognizable symptoms. This supposition is justified by the common observation that exertion and overwork are promptly accompanied by symptoms of an increased toxemia. During this period rest is desirable. It is unfortunate, however, that this period is not always recognized. If the disease is at all extensive prior to the time that quiescence has been attained; it is often during rest, and nearly always during exercise, accompanied by some degree of malaise, a decrease in the patient's endurance, probably a slight rise of temperature, and possibly some cough. The period represented by this condition may last a few weeks or it may last over a much longer time. If this condition could be diagnosed regularly, and the patient be put on the proper treatment, including rest, he would be afforded the best opportunity of overcoming his infection. It is early tuberculosis that is most easily cured. It is unaccompanied by the grave pathological lesions, such as extensive necrosis and fibrosis, cellular degenerations and complicating conditions which add difficulties to the advanced lesion. In the early cases of tuberculosis when the areas of involvement are small, any measure which will raise the balance of resistance in favor of the patient, may cause him to overcome his infection. Rest is a simple measure and one that relieves the patient of large demands and adds to his store of energy, as readily can be seen from the physiological discussion above; and, consequently, is a useful measure at this time.

During this early period of slight activity, the patient usually loses weight if he is exerting, and will gain weight if put at rest, showing that the balance could be easily turned for or against him. Extra exertion also calls for increased pulmonary ventilation. While at rest from six to eight liters of air are taken in, moderate work calls for twenty-five or thirty.

Rest should be a part of the treatment of every case of tuberculosis during this period, and, if supported by other measures, helps to turn the balance in favor of a very large percentage of cases. In order to support this recommendation of rest early in tuberculosis, I wish to emphasize at this point that there is no time in ''clinical tuberculosis'' that is too early for applying our best methods. Clinical tuberculosis is always serious. The chances for the patient's recovery, unless properly cared for, are not more than one in four or five; while, if properly cared for, they are four or more out of five. If it were any other disease than tuberculosis, to which we have become so accustomed and toward which we have become so hardened, it would be unnecessary to make any special plea for the adoption of the best methods at the earliest opportunity.

Rest During Fever (Toxemia).—The importance of rest during fever, which must be considered only as an index of toxemia, can readily be understood. Fever is a symptom which is accompanied by increased oxidation. More heat is formed in the body than can be properly eliminated because the toxins stimulate the vasoconstrictors of the skin and prevent heat elimination; hence heat equilibrium is disturbed and the body temperature rises. Exercise under these conditions has two direct influences in the way of increasing temperature. In the first place, muscular effort produces increased temperature and will add to the amount of heat which is already being produced as a result of the existing toxemia. In the second place, exercise hastens circulation, causes more blood to pass through the areas of infection; and, in this way, compels more toxins to escape into the circulation, thus increasing the number of toxins to be destroyed. It is also obvious that exercise calls for increased quantities of food, while fever diminishes appetite and digestive capabilities; consequently, exercise at this time can only be carried on at the expense of the patient.

Rest is more strongly indicated during fever than during non-febrile active tuberculosis, and all the reasons given in my discussion above hold true during fever to even a greater degree.

Fever in tuberculosis may be due to many different causes, but always suggests that an inflammatory process is present. Except in those cases where it might be distinctly of nervous origin, or due to some other extraneous cause, the height of the temperature may well be taken as an index of the toxemia and the severity of the tuberculous process. Inflammation demands rest, and pulmonary tuberculosis calls for the greatest degree of rest to the body and to the lung that is consistent with carrying on their proper function. Fever may be due to activity in the principal pathological process, an extension of the infection, a miliary condition, pleurisy, or certain complications upon the part of other organs, such as the intestines, the larynx, or meninges. All of these conditions require rest as a part of their treatment. If the disease is at all amenable to treatment, the temperature, as a rule, will be relieved to a certain extent, at least, by the application of rest; and, in many cases, the period of temperature will be cut short.

In the discussions in the literature of tuberculosis as to the proper conditions for rest, the degree of temperature has assumed the most important place. The rule is quite general that all patients who are suffering from a temperature of 99.5° to 100° should be treated with rest.

I do not think that any such arbitrary rule should be made, because there are many conditions, aside from temperature, which are of equal importance in determining the application of rest. I am firmly convinced that all patients suffering from clinical tuberculosis should, at first, be treated with rest. As a general rule, it is safe to say that all patients whose temperature is reaching a maximum of 100° daily, should be treated with absolute rest, yet there are some exceptions to this, particularly in long chronic fevers, where it is expedient at times, to give the patient some relief from the monotony of the recumbent position, and also to give him the encouragement that comes from a little more lenient policy; but, the greatest departure from rest when permitted in these cases, should be that which does not tax his body to any extent, such as sitting in a chair, or probably walking across the room. No extended walking should be permitted under these circumstances. It should be determined whether or not nervousness is an element in the temperature. Temperature is not always kept up solely by the inflammation in the lung. There can be such a disturbance in heat elimination produced by certain nerve states as to cause a considerable rise of temperature. I have seen worry, discouragement, discontent, and anxiety raise the daily maximum temperature from one-half to one degree, over a period of several days at a time, and I have seen these same influences cause several degrees of rise lasting only during the height of the nervous disturbance.

One should not always expect immediate or satisfactory returns from the institution of rest. Rest is not a cure for tuberculosis, nor is it a relief for fever, beyond a certain point. Fever is primarily caused by the toxins from the tuberculous process; secondarily, by the body activities; and if the rest, together with other measures instituted, is sufficient to relieve the active inflammatory condition in the lung, or to reduce the oxidation processes within the body, so that the combined heat production lies within the point of the patient's tolerance, then the fever will disappear. If not, it will continue; but, whether it continues, or not, rest is demanded. Many temperatures will return to normal, or nearly normal, after a few days or weeks of rest. Others will take a much longer time. I have kept patients at rest for a period of many months before their temperatures subsided. In a few instances, I have been obliged to keep the patient at rest over long periods, even of one or two years, before a satisfactory subsidence of temperature was obtained. In these instances, from the pathological standpoint, I did not expect immediate relief, but I did expect the absence of exercise to relieve the patient of as much temperature as extra oxidation caused by exercise would cause. This it did. In other instances, no matter how long rest is maintained, temperature will continue, and the patient go on to death.

One cannot intelligently carry out any line of treatment without having a fair knowledge of the pathological conditions present, because he must ever account for his symptoms by the process that is going on within the body of his patient. If he understands this he will apply his remedy with greater knowledge and less disappointment. He will be satisfied in knowing that his remedy is right whether the pathological changes yield in a satisfactory manner or not.

Rest During Hemoptysis.—As has been discussed more fully in my chapter on hemoptysis, rest should be enjoined at the least show of blood. While this may seem overcautious, yet it is a wise precaution; for a small streak of blood, or a small mouthful may come from a minute opening in a large vessel. If rest in bed is adopted at once, together with proper mental quietude, blood pressure is lowered, and conditions favorable to closing of the vessel result. Such rest should be maintained until all danger of hemorrhage has subsided. If the hemorrhage is due to a break in the vessel, exercise at this time, particularly strenuous exercise, may bring on a frank hemorrhage.

While thus suggesting rest as the initial treatment of all hemorrhage I am not unmindful of the fact that the type of hemorrhage which I have discussed as being due to congestion or of local toxic origin, is relieved best by exercise. Such exercise, however, should be very mild, and conscientiously applied. Owing to our inability to differentiate these types at first, however, all hemorrhages should be treated by rest until it is definitely found that the bleeding is of toxic origin, which will usually require an observation of one or two days.

The danger of small premonitory hemoptyses or blood spittings being followed by severe hemorrhage may be illustrated by a case which came under my observation a few years ago.

A young man had been suffering from a chronic tuberculosis of the fibro-ulcerative type. He had not shown very marked activity at any time, although he had a slight rise of temperature occasionally. One day he expectorated a mouthful of blood. I urged him to be quiet, which he did. The next day the sputum was free from color and he insisted on going to the city to transact some business; and went, against my advice. Being a medical man, he insisted that the danger had all passed. On his return from the trip, he alighted from the car, was taken with a hemorrhage, and expired a few minutes later. This is an instance where the fatal hemorrhage might possibly have been avoided, had the premonitory hemorrhage been treated with proper respect. I have seen so many cases where a slight hemoptysis preceded a severe hemorrhage that I have learned to treat all cases of hemoptysis with respect. I prescribe rest for a day or two until the danger has been avoided, unless I am absolutely convinced that the process is of the toxic type.

The Effect of Rest and Exercise Upon the Heart.—One of the most important organs to be considered in tuberculosis is the heart, therefore it must be given the most careful consideration. The heart bears the brunt of the fight in tuberculosis. Particularly is this true after the disease has become extensive. During all periods of the disease this organ is affected by toxins and also by disturbances in the inspiratory act as described in Vol. I, Chapter IX. From the inflammatory condition in the lung, with its destruction of tissue and obliteration of vessels, together with the catarrhal conditions of the air passages, and the emphysema which develops, the right heart is subjected to an enormous strain in order to overcome the resistance which is offered to the pulmonary circulation. Late in the disease the heart shares in the general wasting and degeneration and loses tone. When we add to this the fact that nearly all cases of advanced tuberculosis have the heart pushed and pulled out of place by compensatory emphysema and contraction, and bound down and embarrassed by adhesions, we see how difficult it is for this organ to perform its work. In spite of all these conditions, the heart will often maintain an equilibrium and be able to carry on circulation in a very satisfactory manner; but these various difficulties impress upon us the care with which the heart must be regarded in pulmonary tuberculosis. The heart is given a certain amount of reserve strength, and, until this is used up, it is able to meet extra demands upon it; but, after this is exhausted, then its power to meet extra demands is gone. Exercise is carried on by extra oxidation. Extra oxidation means more blood to the part which alone can be furnished by the heart. Consequently, not only during the time that the disease is active, but at all times when the heart is laboring, it is the duty of the physician to prescribe rest, or an amount of exercise which will not go beyond the reserve power of the heart. There is another difficulty on the part of the heart which militates against exercise in tuberculosis, and that is the reduction in the inspiratory act, together with general wasting and flabbiness of the abdominal muscles. The increased amount of blood that is made necessary by exercise is drawn from the splanchnic reservoir. Owing to deficient inspiratory act, and reduced tissue tone, in pulmonary tuberculosis, a relatively smaller amount of blood is delivered to the right heart than under normal conditions; consequently, the heart is, at times, unable to meet the extra demands, if they be at all great.

During the period of active disease, accompanied by toxemia and temperature, the integrity of the heart muscle, as well as other tissues of the body, is affected in such a way that it is unable to do full work. Many are the times during the course of this disease when injudicious exercise will put a strain upon the heart which, if often repeated, will cause irreparable damage. I have seen many hearts that were so injured during the early stage of the disease that there was no possible opportunity for them to regain their tone; and, of course, the patient's life was sacrificed as a result.

Often, during the course of tuberculosis, the heart shows symptoms of strain. This is particularly true in advanced tuberculosis after widespread destruction and fibrosis have occurred. This condition calls for absolute rest, otherwise dilatation will result, and death may follow. There is a combination of symptoms that is usually present under these conditions, but is usually overlooked unless the observer is particularly watching for them. These are irritability, anxiety, insomnia, lack of appetite, disturbed digestion, and rapid heart action; in fact, the nervous group often comes before the increase in pulse rate is marked. Precordial pain, which is often found with dilatation, is usually a symptom which comes on later, but this group of symptoms should make one think of heart strain and impending dilatation, and should call for rest as the most important factor in therapy.

Thus far I have considered more particularly the effect of rest upon the heart; but from the discussion one may ascertain the manner in which the heart is influenced by exercise, and when exercise may be judiciously employed.

It will be recalled that one of the principles of Brehmer's therapy was based upon the influence of exercise upon the heart.

While we do not consider the action of exercise upon the heart as being one of the greatest principles in the modern therapy of tuberculosis, yet the influence of exercise in strengthening the heart must be recognized. There comes a time in nearly all cases of tuberculosis which are progressing favorably when the heart is no longer affected by toxins, and when it has adjusted itself to the changes which have a tendency to embarrass it. When such a time comes, gradually increased exercise, carefully adapted to the heart's strength, will increase its efficiency, rather than harm it. It should be entered upon cautiously, and the effect watched carefully. If the condition of the heart has been such as to make it necessary for the patient to remain quiet in bed, then the first exercise should consist simply of sitting up in bed; later, sitting in a chair, and then walking across the room, always observing the effect carefully. Exercise short of strain is valuable, but exercise accompanied by strain is followed by harmful results. When the heart has been subjected to severe strain, then the effect of exercise must be carefully watched. Sometimes exercise, under these conditions, is followed by a rapid heart's action, which returns to normal very slowly. At other times, where there is a marked myocardial disturbance; instead of an increase in pulse rate, there is a decrease in the pulse rate following exertion. Both conditions call for a careful adjustment of exercise to the strength of the heart muscle. When the heart is injured, exercise to the point of dyspnea should be avoided. If the heart is responding to exercise in a satisfactory manner, it will soon be noted that the degree of rapidity of its action becomes less and less as exercise is persisted in; and that the number of contractions become normal quicker after the exercise is ended. If the pulse becomes more rapid and weaker, it shows that the exercise is not being borne well, and should be restricted or withheld for a time.

Where a rapid extension of the pulmonary process is taking place; or where a pneumonic condition is present; or where, as a result of a rapidly destructive process widespread obliteration of the pulmonary vessels is throwing extra burden upon the heart, rest is essential. Under all these conditions the heart muscle is weakening and the demands upon it are increasing. As a rule, rapid heart's action calls for rest, whether the cause be in the heart muscle itself, in the condition of the vessels, or in the innervation of the organ.

The Effect of Rest Upon Cough.—During the periods when the disease is active, likewise when fibrosis is forming and contractions are taking place, exercise is prone to increase cough. Cough becomes a serious form of exercise in tuberculosis and becomes very taxing upon the patient at times; consequently, if it is excessive, rest should be demanded. Coughing should be discouraged as much as possible because it uses up the patient's strength and, besides, has a tendency to cause a spreading of the disease, particularly by way of the bronchi; severe cough forcing the bacillus-bearing sputum into the bronchi, and plugging them. Because of its explosive action, it has a tendency to tear the delicate fibrous threads which nature throws out to heal the lesion; and it puts extra force upon the air vesicles, impairing their elasticity and causing an emphysematous condition. Thus, rest may not only relieve the paroxysm of cough, saving the patient from extra exertion, but it also lessens the danger of injury to the lung. The importance of this is much greater than might seem at first thought.

Rest When Dyspnea is Present.—In pulmonary tuberculosis, the following conditions are present which favor dyspnea: reduced pulmonary ventilation; decreased circulatory activity; and blood whose oxygen carrying power is reduced. When either of these, or any combination of these conditions is present, rest should be enjoined. The factor in common in all of these conditions, which favors dyspnea, is the lessened supply of oxygen to the tissues, which results in a decreased oxidation and acid retention. When sufficient oxygen is not supplied to the tissues lactic acid is formed and the degree of alkalinity of the blood is lessened, resulting in oxygen hunger or dyspnea. Exercise greatly increases oxidation; and when the power to properly supply the demands of the tissues for oxygen, is lessened, as it may be from either of the above conditions, acidosis must result. From this it may be seen that a perfectly normal acid-alkali balance might be preserved while the patient is at rest, even though there is marked disturbance on the part of the respiratory and circulatory system and a marked decrease in the quality of the blood, and yet, if extra demands for oxygen are made by exercise, the organism finds itself unable to supply it, and the result is an increased acidity, with the resultant air hunger or dyspnea.

Every observing practitioner has noticed that patients are oftentimes comfortable and breathe with regular movement when at rest; but have dyspnea of various grades on exertion. Whenever we see the approach of dyspnea on exertion, exercise should be avoided, and should dyspnea be present, while the patient is at rest, we know that a serious condition exists.

There is one exception to the last statement that should be mentioned. Dyspnea is often due to a fat, flabby condition, such as is produced when the patient has gained rapidly and is maintaining a weight far above his normal. Where such is the case dyspnea is not a contraindication to exercise, but demands that gradual exercise should be prescribed, beginning with very mild movement at first, and increasing to the patient's tolerance, the latter being determined by the general condition of the patient, rather than by the amount of his dyspnea alone.

When the Nutritional Balance is Against the Patient.—When the patient is finding it difficult to gain, or is losing weight, his nutritional balance can best be maintained by rest. It is not always desirable to prevent loss of weight. There are seasonal changes which are natural. Every spring, as the warm weather approaches, a natural loss in weight takes place. In the fall, when the cooler weather comes on, a gain in weight also naturally occurs; but, when the patient is losing weight because of the pathological changes present, such loss will be increased by exercise, and will be checked or reduced to the minimum by rest. The reason why rest should be prescribed under such conditions is because of the extra demands which the exercise makes upon the responsive powers of the patient. If the demands for energy, caused by the disease present, when added to those made by the exertion of the patient, are greater than the patient's recuperative powers can supply, then a loss of weight will ensue. If, on the other hand, exercise is able to stimulate a greater appetite, as it sometimes is, particularly when the demands made by the pathological process are slight, such loss may be more than made up and the weight increased.

Overfeeding, as it was formerly carried out, was always most successful in putting on weight when the patient was at rest.

The Weir Mitchell treatment was also based on this physiological principle. The farmer, likewise, takes advantage of it in fattening his stock for market. It is found that if much exercise is permitted the weight does not increase as rapidly per unit of food as it does when exercise is limited; consequently animals are confined in pens when they are being fattened.

When Nerve Exhaustion is Present.—The great majority of tuberculous patients suffer from some degree of nerve exhaustion. Tuberculosis is a chronic disease. It is often present for many years before it manifests itself as a clinical entity. During this period, however, at intervals, the foci are active, and toxins, which have a particular action upon the nerve cells, are thrown out into the blood stream. By the time the disease has reached such a degree of activity as to produce recognizable clinical symptoms a degree of disturbance in nerve balance is present in practically all patients. In many instances this degree of neurasthenia is so marked that it is taken for the predominant condition.

It is evident that many patients who have been treated by the Weir Mitchell treatment for neurasthenia, have been relieved not only of their altered nervous state, but have been given the strength to overcome an active tuberculosis, which was the underlying factor in the nervous manifestations.

It is necessary to give careful attention to the nervous side of patients. When I find one suffering from marked neurasthenic symptoms I always treat him with rest. I put no extra demands upon the body, but aim to relieve it as much as possible, both from the physical and nervous standpoints, until both the physical and nerve balances have been raised, as I shall describe in greater detail later.

A neurasthenic condition in tuberculosis demands sympathetic care rather than an attitude of criticism or blame. By the long continued bombardment of their nerve cells by toxins the threshold of response is lowered and the nerve discharge is sent out with less stimulus than would be normally required. Their cells discharge at a lower load than normal. In order to restore them to their normal nerve, as well as physical balance, rest must be maintained. Depressive emotions must be avoided as much as possible; and the patient must be made to understand that he has pains, fears, discouragements, and a discontented frame of mind because this threshold of response in his nerve cells is below normal. When he assumes this attitude, he will avoid many anxieties and worries, the tone of his nerve cells will improve, and the threshold of response will be gradually raised. In carrying out treatment of this type, I have found rest to be essential. I have never been able to obtain the same cooperation and the same satisfactory result with a patient treated from the beginning with exercise as I have when rest was employed. The reason for this is that during rest ideal conditions for restoring lost power are maintained, while exercise tears down and makes extra demands, under conditions which are unfavorable for repair.

Indications for Exercise.—It is well to ask at this point, "Under what conditions is exercise permissible in tuberculosis?" Nearly every serious condition which presents during the course of the disease demands rest. There are times, however, when these various complications and clinical symptoms disappear; then exercise becomes an important measure. Exercise increases oxidation, calls for an increase in metabolic activity, keeps the body fluids moving, and, when no contraindications are present, it should be employed, always suiting it to the particular requirements. When exercise can be utilized digestion and assimilation usually improve, sleep is promoted, and the activity of the various secretory organs, such as those of the skin, kidneys, and bowels is increased; therefore its usefulness cannot be questioned. In early stage cases, after all activity is past, if there are no contraindications, such as mentioned above, an amount of exercise equivalent to a walk of from three to five or six miles per day should gradually be attained, according to the general strength of the patient. Advanced cases must take on exercise with greater care, particularly if there has been a marked loss of lung power and marked strain on the heart. *It is not exercise in itself that is valuable, but it is the amount of exercise that the patient can take with benefit.*

Technic of Prescribing Exercise.—Where exercise is to be prescribed, the physician should know the distance between different points; and, where it can be done easily, it is best to know the distance by measurement, although it is not essential. In the city this can be done very nicely by prescribing so many blocks.

In the city, when I have patients who are able to walk, I start them out at first, walking only a single block; then I have them increase one block per day until five are reached. This is repeated several days. Then I have them increase to ten blocks which they repeat for several days; then to twenty, then thirty, or forty, and even as high as fifty; never increasing more than one block per day. If they find at any point that the walk seems to cause tiring, I have them repeat that until they do it with ease. If the walking is interrupted for several days, for any reason, I have them resume at three-fourths, or half the distance they had attained. It is surprising to see how rapidly muscular power is regained. The patient whose maximum exertion may be that of sitting up three or four hours a day, may be started on walks and attain a distance of a mile within two weeks, and two miles, or more, within a month, without doing harm, providing the conditions present do not contraindicate such rapid increase of exercise.

During the early weeks of treatment I keep all patients quiet. During this period we are learning to know them better and to obtain a fairly accurate idea of their disease and the various complications present. We also learn to know their individual weaknesses and their points of strength, and form a more or less accurate opinion of the degree of cooperation that may be expected. Exercise cannot always be based upon the patient's ability to take it without harm. Many times it is best to prolong the period of rest because of a disposition on the part of the patient to take too great liberties when exercise is once permitted. It is such an easy thing to overdo and spoil one's chances of recovery that careful supervision of exercise is imperative.

There are certain times of the day when it is best for exercise to be taken. Strenuous exercise should not be taken immediately prior or immediately following a heavy meal. The objection of tiring cannot be interposed because proper exercise for the tuberculous patient is always short of tiring; so, a little exercise prior to a meal is not wholly bad. Tiring immediately before meals, no matter what the cause, should be avoided; for it takes away the appetite and decreases the digestive powers. It is always advisable, though not always practicable, to develop as high a degree of physical endurance, on the part of the patient as is consistent with his general strength, before he is dismissed from the physician's care. This cannot be done, however, in those cases which remain under treatment for only a short time. When I am able to keep my patients under my care as long as is necessary to obtain the best result, I keep them in bed most of the time, during the early period of treatment. This period varies from three to six or eight, or more, months. I then start them on exercises, the amount and strenuousness of which is carefully suited to the patient, the stage of his disease and the complications present. I keep them at rest, if possible, until all activity has ceased and all contraindications, such as mentioned above, have disappeared.

In order to relieve the monotony of treatment, a close personal supervision is maintained. Rest in bed is relieved after a few months by allowing the patient to sit up a few minutes each day. When the patient should be permitted to sit up in bed depends upon the individual and the degree of activity of his disease. I nearly always allow the patient to sit up in an easy chair while the bed is being made, from the start; and, when the symptoms of activity have subsided satisfactorily, as shown by the temperature and other conditions present, I increase the period of sitting up from five to ten minutes per day. When one and a half hours has been attained, I divide it between the morning and evening; and then add to each period, until the patient sits up for two or three hours per day. I then allow a little walking in the room, or probably to a neighbor's room. When the patient can sit up, without doing harm, for four or five hours a day, a little more exercise is prescribed. At first I do not let the patient go more than one hundred feet from his bed; and then increase this gradually until he is able to walk a distance of one quarter or half a mile without tiring, or without harmful results.

The rule in treating a chronic disease like tuberculosis is to make every point good. This applies to both the mental and physical side of the patient. While such precaution may seem extreme, yet the results will offset any criticism that may be made. I formerly accepted the general rule of making my degree of exercise depend largely upon the patient's temperature, but was often confronted with the necessity of returning the patient to bed, after he had been allowed a certain degree of exercise. Since I have adopted a more careful plan, however, such a thing is almost unknown in our institution, as to send a patient back to bed after he has been permitted to start his exercise. If the patient remains under treatment long, his tolerance should be brought up under the careful supervision of the physician before he is discharged. This is where mistakes are often made in sanatoria. Patients are kept well; they live under ideal conditions; they are fat, but not strong; they leave the institution with its careful regime, its hygienic surroundings, and go back to their homes where there is constant temptation to break their routine; and, as a result, they begin losing weight and feel discouraged. If the result was not a satisfactory one; that is, if the disease had not become well arrested, it is not uncommon for such a change to be followed by an early breaking down. If the patients could, and would, allow themselves sufficient time for treatment, they should be brought to a point where they can maintain nutrition on an ordinary dietary, and where they can endure exercise such as they will be called upon to perform when they leave the institution, before they are discharged.

Suitable Exercise for the Tuberculous.—*There is no doubt that injudicious exercise, or exercise at a time when it should have been avoided, has been responsible for the death of more tuberculous patients than any other measure.* On the other hand, when the proper time arrives in the treatment of tuberculosis, exercise is extremely important; but its character must be carefully suited to the patient. All things being considered, I am of the opinion that walking is the best form of exercise for the tuberculous patient, because the degree of exertion can be adapted to the patient's needs more easily and more accurately than any other form of exercise. It is not like such competitive games as golf and tennis, which are entered into with a desire to win and where a definite amount of effort is essential. Walking can be interrupted, or stopped, at any point without interfering with the pleasure of others. Games of contest, on the contrary, always have a tendency to spur the individual on to a greater and often more prolonged exertion than his strength will permit. Tennis is not permissible because the degree of exertion is far too great. Croquet makes a pleasant game and requires a minimum of effort; but, even with this, we often find that the interest grows so acute that the patients will overdo. Quoits can be entered into by those who are free from activity. Walking should be entered into leisurely by those whose strength is materially undermined, while those who are able to take three or four miles readily may assume a more rapid pace. For those who are weaker the walk should be in the nature of a stroll. The pleasure of walking is greatly enhanced if the paths lie through pleasant surroundings. This also adds to the interest and offers the patient diversion for his thoughts. Walks should be on the level, particularly for those who are weak; or only on a slight grade. Hill and mountain climbing require so much extra exertion that the patient is very apt to overdo before knowing it, consequently, I rarely permit this, even to those who seem able to stand it.

When exercise is being prescribed it is well to bear in mind that the patient must not go so far from home that he cannot return refreshed instead of tired out. If he finds himself tiring at any point he should stop and rest. The patient should not walk fast enough to cause coughing, shortness of breath, nor should the exercise require any rise in temperature, or undue activity on the part of the heart. These symptoms are proof that exercise exceeds the limit of safety.

Horseback riding has often been recommended. The idea of Sydenham is firmly ingrained in the minds of the medical profession. Personally, I consider horseback riding entirely too strenuous for the great majority of patients who are suffering from tuberculosis, or who have recently attained an arrestment.

Horseback riding does invite the patient to be out of doors and in this way adds to the pleasure; but my observation of those who have tried to take their exercise in this way is that their interest is so much centered upon the ride that they forget that they are patients.

"Roughing it" has been thought to have special curative powers for the tuberculous; but a moment's thought given to the pathology of the disease, will show that only such value can come from "roughing it" as depends upon the life in the open and the stimulus from the particular surroundings. Thus, "roughing it" in pleasant places is of far greater value than in places which are tiresome. It must not be forgotten, however, that the invitation is constantly present for the patient to overdo, and go beyond his strength. My observation is that injury happens to far more patients as a result of this measure than benefit.

Automobiling is another form of diversion which is too often employed to the detriment of the patient. It is a diversion, but not a rational or valuable exercise. It tends to get the patient away from the regime necessary to best results, without giving a proper return.

The patient suffering from tuberculosis must make up his mind that the arrestment or cure of his disease is more important than entertainment. *If he expects to be entertained and find the cure of tuberculosis wholly pleasant,* his chances of cure are decidedly few. If, on the other hand, he is willing to approach the treatment of this disease, with an understanding of the sacrifices which are necessary, then the question of amusement will not assume so important a place in his mind, and his opportunity for obtaining a favorable result will be greatly enhanced.

Diversion is essential, but diversion can be provided for the patients, particularly in sanatoria, by a well planned regime, starting in the morning and continuing the entire day, something being done for the patient at frequent intervals. A regime like this will lessen the demand for amusement and make the time of treatment weigh less heavily upon the patient.

In Southern California, and other localities, which are in close proximity to bodies of water, there is a desire on the part of patients, to engage in swimming. I consider swimming, particularly in the surf, or against the stream in rivers, as being one of the most strenuous of exercises. Aside from the strenuousness of such exercise, harm is likely to result at times by patients failing to react. If they stay in the water long enough to become tired their reacting powers are reduced. Then, if the skin is not rubbed sufficiently, and measures are not induced to quicken the circulation, chilling is apt to follow; and is, at times, followed by serious result. I have seen numbers of cases of hemorrhage, pleurisy, and pneumonia follow surf bathing; and innumerable cases where activity was started up as a result of such injudicious exercise.

Such games as cards, checkers, chess, and dominoes offer very valuable diversion. Entertainments, either musical, or literary, are also valuable in giving the patients a change of thought; but the extent to which games and pastimes will be resorted to will depend largely upon the physician who is treating the case. His personality and power to obtain cooperation will often reduce the necessity for diversion.

Graduated Exercise.—Graduated exercise, as carried out in the modern treatment of tuberculosis, is a genuine contribution to the therapy of this disease. The systematic work done by Marcus Paterson[5] deserves more than passing attention. While we may not agree wholly with the ideas of this writer, yet he has developed a plan whereby patients' resisting power may be gradually increased by permitting them to do only such work as they are able to do without producing certain symptoms, which he has interpreted as being due to an autoinoculation, or overdose of tuberculin from their own tissues.

Paterson is extreme in his use of rest during the period when the patient is intolerant of exercise, meaning by this when he will have a rise of temperature, headache, or other symptoms which are attributed to extra toxemia upon exertion.

It has been observed that tuberculous patients gradually become dependent and seem disinclined to work. It is due to the patient in explanation of this fact that it be understood that tuberculosis is a chronic toxemia which exerts a deleterious effect upon the nerve cells over a long period of years, and, through them, interferes with all cellular activity; consequently, it is not surprising that patients should eventually lose their nervous stability and suffer a diminution in their natural energy and ambition, and assume an attitude of indifference. The best way to overcome this would be to prevent tuberculosis from being a long drawn out chronic toxemia, that is, bring the disease to a healing early in the life of the patient; or, at least, as soon as it manifests itself clinically. If the disease has extended so as to produce, directly, or indirectly, marked nervous instability and physical deterioration, it is impossible to restore the patient to a 100 per cent efficiency.

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[5] Auto-Inoculation in Pulmonary Tuberculosis, James Nisbet & Company, Ltd., London, 1911.

Much can be done, however, to prevent the patient from becoming lazy and indifferent by gradually developing his powers of tolerance during the period of treatment. It is very important that members of the working class, at least, should go through tuberculosis and still retain their earning capacity; and, unless careful attention is paid to gradually increasing the patient's tolerance for exercise, this object will not be attained; and, because of this, I have become more and more a convert to the idea of making exercise an important factor during the last months of treatment of all of my cases of tuberculosis that have reached an arrestment.

The amount of exercise that each patient can do, and do advantageously, will differ greatly. Sometimes a patient with a comparatively early lesion will be able to do very little, while a patient with a widespread infection may be able to do heavy work and still improve his health.

In the development of Paterson's idea of graduated labor, the first exercise which he prescribed is that of walking, the distance being gradually increased up to ten miles per day. When the patient reaches this stage he is given a basket, and made to carry mould or dirt for spreading on the lawns or other purposes. Then, after a month, he is given a small spade and permitted to dig about five minutes at a time, followed by an interval of five minutes' rest. After carrying out this degree of labor for a few weeks those who are able to stand it best, are "allowed to work as hard as possible with their small spades, without an interval for rest.". Then, as they become able to carry on work of this kind without any ill effects, they are given larger spades and shovels and permitted to do more strenuous work.

The great difficulty in establishing a method of this kind is to be sure that the patient does not overdo. The tuberculous patient is very apt to underrate his disease and overrate his ability to do, particularly if he is doing something in which he becomes interested or something that pleases him. He is also liable to misjudge the necessity of care. Paterson adjusts his work to his patients with great precision. He watches the temperature and other symptoms very carefully, and believes that a rise of 99° F., coming on with work, is an indication that the exercise is too violent. He explains the rise of temperature as being due to the inoculation of too large a dose of tuberculin from the patient's own focus. A patient having a rise of temperature to 99° during work is ordered to bed, with rest, for a few days, after which he is put on less strenuous work for a short time until he is able to resume the work which he had done preceding his overexertion.

Paterson makes the rule that loss of appetite, presence of headache, and rise of temperature are dangerous symptoms, which it is "fatal to ignore."

From my study of the physiology of exercise, and realizing the difficulty with which patients suffering from tuberculosis are able to bring about the ideal conditions for the proper exchange of oxygen and carbon dioxide, I cannot help thinking that many of these slight rises of temperature and headaches are due to a storing up of lactic acid in the system, rather than an increased autoinoculation of tuberculin, and that the rise of temperature is an index of increased metabolic activity not wholly representing the destruction of increased toxins, but an increased oxygenation caused by the muscular work and decreased elimination. No matter whether the explanation is correct or not, Paterson's idea of graduated exercise is in accordance with sound physiological principles, and, if his methods are carefully carried out, patients will be discharged from their treatment in the best possible condition for earning a livelihood. I feel that the principle carried out by Paterson is extremely important from both the standpoint of the patient as an individual and as an economic member of society.

The success of Paterson's work is a tribute to his personality. Its success in other hands has been in accordance with the physician's knowledge of the principles underlying it, attention to detail, and the degree of enthusiasm with which he undertakes its application.

Rest Hour.—No matter whether the patient is treated by rest, or whether he is allowed some exercise, it is very important that he should observe a period each day during which time a condition as near physiological rest as possible is maintained. The hours from waking to retiring are too long for the average patients suffering from a chronic strength reducing disease like tuberculosis. They approach the end of each day in a condition of partial exhaustion, unless rest is interposed. We owe the establishment of a rest hour to sanatoria. Where patients are treated in institutions it is easy to make a rest period part of the general routine. This rest hour breaks the day and makes two short periods of activity instead of one long one. The patient awakens in the morning, pursues the activities which are permitted until one or two o'clock,—whenever the rest hour begins, and then has complete rest, without visiting or reading; sleeping, if possible. The rest period should usually be about two hours long during the stage of active treatment. As a result of the rest period, the patient is refreshed and spends the remaining portion of the day in a condition of high resistance, instead of that of partial exhaustion. This gives the protective forces of the body a better chance to operate. It is difficult to make patients keep rest hour conscientiously. They do not see the importance of it, as do those who are managing the case; consequently, it must be insisted upon and urged, otherwise many patients will grow careless in its observation.

Few people know how to rest. This is one place where the physician must explain carefully, so that the patient will thoroughly understand the purpose of this therapeutic measure. Reading is not resting; playing games is not resting. The patient should give himself the benefit of as great a degree of mental and physical rest during this period as he possibly can after conscientiously trying. Sometimes patients insist that they cannot rest, that they are too nervous, and that the attempt makes them restless. These are the patients, above all others, who need rest most. The patients who can take rest hour easily and readily do not need it nearly as much as the high spirited individual, who is always overexerting and facing a nervous explosion, and feels that he must keep moving or doing something in order to control his forces. Such patients live too fast. A period of relaxation during each day is invaluable to them. Lying flat on the back without pillows, on a firm bed, is a valuable means of helping the patient to gain self control. It relaxes the muscles of the body to as great a degree as possible; prevents undue tiring and enhances the total resisting power of the patient.

Rest and Exercise for the Lung.—If the alveoli of the lung were spread out they would cover an area of from one hundred to one hundred and forty square yards. In these alveoli the capillaries are minute,—so small that the blood corpuscles travel through them singly. On the other side of the blood, in intimate relationship with the vessel walls is the alveolar air. This intimate relationship is provided in order to make the exchange of oxygen and carbon dioxide take place readily. Oxygen is taken up and carried by the corpuscles, plasma and lymph, while carbon dioxide is given off from the same sources. Man is fortunately given a larger amount of pulmonary area than is required for the purpose of carrying on oxygenation. He can suffer a considerable diminution in this area without great inconvenience. He can lose one-third of his lung and still live an active life. He can exist at rest on one-half the normal volume. The comparatively small amount of lung area that is consistent with life was impressed upon me a few years ago at the postmortem of one of my patients. This man had travelled from Portland, Oregon, to the sanatorium one month prior to his death. His left pleura was completely filled with pus, there being no functionating lung. The upper lobe on the right side was a cavity, there being only a shell about one-half inch thick surrounding it. The lower lobe contained cavities at the apex and was one mass of scattered caseous tubercles. Of course, such a condition is inconsistent with exercise. On the least exertion, even turning over in bed, the patient suffered from dyspnea. How he had existed and taken this long trip so shortly before his death is difficult to understand.

There has been considerable discussion in tuberculosis literature on the subject of deep breathing versus rest of the lung. Some men invariably prescribe deep breathing. This is particularly true of those who teach physical culture. It is the almost universal opinion among them that deep breathing will prevent tuberculosis or, when present, will cure it. This idea is held by many laymen. It is not uncommon to hear the expression that such a person could not have tuberculosis because of being a singer and being accustomed to take deep breaths. Such statements are not based on scientific reasoning. Deep breathing is neither a prevention nor a cure for tuberculosis. Deep breathing hastens the circulation. It sucks the blood from the venous reservoirs, and relieves circulatory stagnation. It also improves oxygenation. Consequently, when no contraindications are present, it is of value; but, when there is active inflammation, harm may be done in other ways, which will more than overbalance any supposed good.

As a result of deep breathing, the circulation is hastened throughout the lung; as well as in the general system and an increased amount of blood forced through the active inflammation in which toxins are being formed. These toxins are forced out into the circulation and make extra demands upon the vital forces for their destruction.

When the disease is active, the bronchi contain secretions. Deep breathing has a tendency to aspirate these secretions into the areas which are not already involved, and spread infection. Deep breathing may also cause a scattering of infection by way of the lymph channels. As far as the scattering of infection is concerned, it seems that conditions favorable to it exist on both deep and shallow respiratory movement. Quiet to the lung favors stagnation in the lymph and blood current and this favors implantation through lymph channels; while increased motion causes the contents to be aspirated into unaffected bronchi, favoring bronchogenic dissemination. We can form our judgment, as far as the necessity of deep breathing is concerned, from nature. While the inspiratory act is both voluntary and involuntary, yet, whether we think of it, or not, respiration is carried on, and the body requirements for oxygen are satisfied. If there should be a deficiency of oxygen in the tissues, the result is a decreased alkalinity of the blood and acid retention. This at once causes conditions which stimulate the respiratory center and call for increased pulmonary ventilation; and this condition is met by more frequent or deeper respiration. When the requirements are great, the accessory mechanism of respiration will be called into action wholly as an involuntary matter. It was formerly thought that the tuberculous patient was particularly suffering from a need of more oxygen, and that this was met by deep breathing. The fact that he did better when put in the open air was taken as proof of the supposition; and now that we know that the effects of open air do not depend on increased oxygen supply, the beneficial or injurious effects of deep breathing must result from other factors such as mentioned above. Deep breathing and cough are both harmful forms of exercise as long as the pulmonary disease is active and should be avoided as much as possible.

The question of rest to the lung assumes special importance today since the treatment of tuberculosis by artificial pneumothorax has been instituted. The theory of its application is that by compression the lung is put at rest, the circulatory and lymphatic circulation are slowed, and, in this way fewer bacilli as well as toxins escape into the general circulation. Necrotic areas are compressed; the destructive process is checked; and small cavities are obliterated. The effect of this is to relieve the system of its toxemia; and, to the extent that this is accomplished, the patient's vital reacting powers are improved. It is necessary to state, however, that where compression is instituted, we have no guarantee that the compression will take place primarily or particularly in the diseased area. It seems to me quite probable, on the other hand, that where a partial compression is done, that the normal pulmonary tissue is more apt to be compressed than the pathological tissue. The work done by the compressed lung must be thrown on the uncompressed portion, resulting in a distention of the air cells and an increase of pulmonary activity which, according to the theory that rest is the important thing, should start up activity in diseased areas in the uncompressed portion. This it does at times. That there is efficacy in this lung compression in many cases of tuberculosis cannot be doubted. That it is not the ideal treatment for tuberculosis is equally true.

The effect of this compression of a large portion of the lung upon the pulmonary ventilation and the circulatory system must be carefully considered. Both the beneficial and harmful effects of this measure are discussed in Chapter XLIV, page 307.

CHAPTER XXXIX.

FOOD.

Suitability of Foods.—Errors in diet should be avoided as much as possible where a high state of nutrition is desirable. Errors in diet may be due to the eating of the wrong kind of food, or to eating too much or too little food, or to eating food which is not suited to the nutritive requirements of the patient or the peculiar digestive condition present.

The question of the proper diet both in health and disease is one which at the present time is in a state of uncertainty.

Nutrition may be maintained at different times on variable diets; but, what we would like to find out for the tuberculous patient is, does he have any specific requirements; are there any forms of diet that will aid him more than others in overcoming his disease? The question is one that so far has not been properly answered. Scientific men have not been able to agree upon a proper diet, and laymen have been more or less influenced in their ideas of diet by unscientific faddists. The average layman would give as his opinion that the best food is that which he likes best; and he considers the proper preparation of the food as that which he is accustomed to, and which appeals to his palate. Physicians, on the other hand, have been led into the error of associating the value of foods with what they consider ease of digestion and have taken as their standard the time required for the food to leave the stomach. As Cohnheim[1] says: "If the question is asked what foods are easily digested, and what foods are not, the answer usually given is that carbohydrates, fine bread, sugar, and finely divided meat are easily digested, while fats, fat meat and meat taken in large pieces are not. Why this answer? We all know that the chief seat of digestion, the most important organ of the alimentary canal, is the small intestine. Stimuli which come from the wall or the inner surface of the duodenum and the upper jejunum provoke or check the opening and closing of the pylorus and the movement and secretion of the stomach. They also provoke the secretion of the bile and pancreatic juice.

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[1] The Influence of Sensory Impressions on Scientific Deductions, The Harvey Lectures, J. B. Lippincott Company, Philadelphia, 1910.

"The greater bulk of the food is digested and absorbed in the small intestine. Hence it should follow that an easily digested food is the one which is quickly digested in the small intestine, with the minimal amount of work. We usually find, however, that in recommending a food as easily digestible, the chief importance is laid on the quickness with which it leaves the stomach, * * * * But a study of the composition of the chyme passing through the pylorus in each instance (experimentally proved on dogs) showed that the chopped meat had undergone much less solution and digestion in the stomach than the meat in large pieces. The latter was converted almost completely into peptone, and one-fifth had been absorbed before leaving the stomach. Of the chopped meat 40 per cent had not been dissolved by the pepsin. This shows, then, that meat in large pieces requires more work on the part of the stomach than the chopped meat, but that the latter requires more work on the part of the intestine."

Vegetarianism.—There is considerable discussion these days between the vegetarians and those who believe in including meat in the general diet. This has extended in certain quarters to the treatment of tuberculosis. Such a discussion seems to be trivial and yet it is of considerable importance. In order for the tuberculous patient to maintain his normal nutritional equilibrium, it is necessary for him to have all forms of food. He must have proteins, carbohydrates, fats, and salts. Proteins are furnished best in animal food; and as such, are easier than the proteid of plants to digest; but, on account of certain sentimental notions, and, in part, on account of a supposed danger, there has arisen opposition to the protein diet. It has been noticed that patients who eat large quantities of meat at the expense of vegetables, cereals and fats, have constipation; and, secondarily, patients who suffer from constipation have a chain of symptoms such as lack of appetite, headache, feeling of heaviness, dullness, and inability to perform work. When these patients are put on a vegetable diet they often lose these symptoms, consequently the conclusion is drawn that meat is the harmful factor. The real cause of the symptoms complained of, however, is most probably the fact that the individual is eating too much meat or not receiving sufficient cellulose to produce normal peristaltic movements in the bowel; consequently is suffering from stasis, and a consequent decomposition of the intestinal contents, with absorption of poisons from the alimentary tract. When this condition is relieved by following a vegetable diet, the wrong deduction as to its cause is apt to be drawn. The blame is laid on the meat when it should be laid on the fact of there being too much meat or too small a vegetable intake to go with the meat. When the dietary is so framed that the patient eats a moderate quantity of meat, but along with it, takes sufficient vegetables to produce the normal peristaltic movements, the above mentioned symptoms disappear just as readily as when meat is entirely eliminated. Animal albumen, such as is found in meat, eggs and milk, is a very important part of our dietary for the tuberculous and should be preserved if possible, because it fills a need and furnishes the patient with an essential form of food; and in such form that it can be digested with comparative ease. It is not necessary, however, to use meat and eggs as freely as is often done. The harm is not in meat, but in too large a proportion of meat. The influence of the vegetarian in calling attention to the useless as well as harmful consumption of large quantities of meat has been shown in a more rational use of animal food.

Overfeeding.—The question of the amount of food to be employed in the feeding of the tuberculous patient has changed materially in recent years. In a monograph published eight years ago,[2] the writer said:

"The evil effects of forced feeding are most pronounced on the part of the gastrointestinal tract. The stomach often manifests rebellion against it in the form of nausea, and, if this warning is not heeded, chronic indigestion, either with or without dilatation may ensue. The intestines show their disapproval of it by disturbances in their functions. The patient may have an undue amount of gas formation causing a feeling of fullness and discomfort, or he may suffer from obstinate constipation, or he may have two or three loose mushy passages a day often containing undigested residue. A common symptom also is a pain in the lower part of the abdomen, this pain may be increased by the taking of all forms of food. Dizziness and headache are also common symptoms. Upon the part of the heart, overfeeding is shown by an increase in the pulse rate. There is no question but that the kidneys are often injured by overfeeding.''

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[2] Pulmonary Tuberculosis, William Wood & Company, New York, 1908.

It has long been a common observation that patients who are below their normal body weight, as a result of illness, usually regain this weight coincident with their improvement. Tuberculosis, particularly advanced active tuberculosis, is one of the diseases which is attended by a pronounced waste of body tissues, as its name ''consumption'' implies. Therefore, when science began to cope with this disease it was but natural that the question of nutrition should have become an important one; and, so important a place did it assume that it led the medical profession into confusion and error. There was a failure to recognize the difference between a high state of nutrition and an increase in body weight.

It was found that tuberculous patients could be made fat by giving them large quantities of food. It was even found that their body weight could be raised to and beyond their normal and be maintained for a length of time by the use of enormous quantities of food. This increase in weight was looked upon as an index of the patient's general improvement, and a gain of 10, 20, 30 or 40 pounds was heralded as a great achievement in the treatment of a given patient.

Experience, however, has shown that there is a great difference between these enormous gains in weight and nutrition. The truth, while slow in making itself felt is now fairly well established among the best clinicians. It signifies very little to the patient suffering from tuberculosis that, by ingesting enormous quantities of food, he is able to make a large increase in his body weight; but, it signifies very much if, by eating moderate quantities of food, quantities such as would be employed by a person in normal health, he is able to put on weight. The latter is nutrition; the former fat.

An important principle in the dietetic treatment of tuberculous patients is that while a high state of nutrition is to be aimed at, fat is to be avoided. Nutrition must be looked upon as strength, fat as useless and harmful weight.

The evil effects of large increases in body weight must not be underestimated. Fat people are not healthy. They are considered poor risks from the standpoint of longevity. They are prone to suffer from diseases of the heart, arteries, and kidneys. This can be readily understood. The heart and kidneys of an individual are sufficient to care for a certain body weight. For example, let us take a normal weight of one hundred and fifty pounds. Let this increase by one-third to two hundred pounds. The organs must still care for the two hundred pounds although they cannot increase in strength and size in proportion. The result is an overstrain and a weakening of the organs. Thus, the man who weighs one-fourth or one-third more than his normal is at a disadvantage instead of an advantage. In the tuberculous this is especially serious because the heart is already overburdened and weakened by the disease; and when the weight is increased by overfeeding it is usually added quickly without giving the organs time for adjustment.

Tuberculosis is not as apt to spread in patients who are in a high state of nutrition as in those who are in a low state; but we have all seen it make rapid progress in patients who were simply fat.

Any patient with reasonable powers of digestion and assimilation can be made fat by overfeeding; but when this has been done little or nothing has been gained. The patient, however, who gains his lost weight on a physiological diet consisting of normal quantities of food must be looked upon as being more resistant than when his weight was low.

Based upon the erroneous idea of fat being beneficial, overfeeding was established as one of the essentials in the cure of tuberculosis. This extraordinary procedure was applied to all patients without discrimination. Patients in the early stages of the disease, who had lost but little or no weight, were overfed the same as those who had lost many pounds. Authority had recommended it and it had to be followed. When we look back at the results of this overfeeding, and I might say, we do not have to look far, because overfeeding is still being practiced too commonly, we find that the patient was often made fat, but that his disease continued to extend. We find, as a result of the overfeeding, serious disturbances on the part of the gastrointestinal tract such as dilatation of the stomach, colitis, constipation, diarrhea, and inflammation of the kidney. While the patient may have been improved for the time, in case his treatment was begun early, if the disease went on for some time, he was often in a serious condition because of the disturbances which had been produced by overfeeding. I have seen many instances where the effect of overfeeding was finally the cause of the death of the patient. We find many patients, who, besides three square meals a day, have taken five or six eggs and one or two quarts of milk for a prolonged period of time until their digestive and eliminative systems have been ruined. When they find themselves unable longer to keep up the use of these quantities they lose weight rapidly.

It is almost impossible to realize the extent to which overfeeding has been carried. I do not doubt that future medicine will look back upon this practice as one of the strangest vagaries of medical practice. The writer personally must plead guilty to the charge of overfeeding, although he never carried it to the extent that many have done. In his early work in the treatment of tuberculosis at a time when he was apt to accept the dictates of authority without question, he gave large quantities of food because the authorities said so; but long since he has learned that where authority clashes with common sense, it is better to follow the latter.

Overfeeding, or forced feeding, as we sometimes call it, is permissible at times, but it should not be carried on for a prolonged period. It is not possible for the digestive and eliminative organs to care for large quantities of food for a long time without harm resulting. Now and then, however, we will find patients who will not improve on ordinary amounts of food. It is possible that the fault is with us and not with the patient. It is possible that we do not know just what this particular patient requires; but until we have obtained this knowledge, I suppose we will have to lay aside judgment and use overfeeding in these cases. In such cases it is not only permissible, but probably the best thing that we know to do at present.

Underfeeding.—Many patients who are suffering from tuberculosis are inclined to take too little food. We see the young girl, who is in the habit of living on sweets and salads; we even run across grown people who are in the habit of picking at this and that, eating the things that they like and omitting things which they do not particularly care for. Such patients are necessarily undernourished and if such underfeeding has been carried on for a prolonged period of time the effect shows upon the patient. The musculature is usually below normal, the nerve tone is below par, the patient's endurance is reduced and her resisting power to disease is very much below what it should be. We find many of these cases among the tuberculous the same as we do among the non-tuberculous; and it is the duty of the physician to help them overcome their vicious habits of eating, if possible. Many of the cases described by Stiller[3] as *asthenia congenita universalis* belong to this class. The method which I have suggested of having the patient keep an accurate record of what he eats, has proved very helpful to many of these patients in overcoming this habit. Often when they themselves see how little they are eating they strive to increase the amount.

Not only do we have the naturally small and insufficient eater among our tuberculous patients, but many whose appetites are temporarily or permanently impaired as a result of the disease.

This loss of appetite may be due to the toxins and come on at any stage of the disease; it may be of reflex origin; it may result from an overburdened heart muscle; it may be due to many different disturbances in the function of the gastrointestinal tract or to actual pathological changes. It is often an early symptom of tuberculous involvement of the intestine, and sometimes due to mental depression and discouragement. Its seriousness depends on the length of time that it lasts and the degree of activity of the tuberculous process.

During this period of lack of appetite the physician's skill and the patient's will power are often taxed to the limit. Knowing that many of the causes are temporary and removable, the cause should be determined when possible, so that extra effort may be put forth when relief is possible. It is in these cases that we often resort to milk and eggs to the great advantage of the patient. Nutrition should be maintained at as high a point as possible so that when the cause of the inability to take food is removed, the patient's body cells will be able to react and assimilate food.

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[3] Die Asthenische Konstitutionskrankheit, Stuttgart, Ferdinand Enke, 1907.

Rational Diet.—Quoting from the writer's monograph[4] on tuberculosis, "A rational diet is one which suits the needs of the particular patient in question. There can be no one diet for all cases any more than there can be one suit of clothes to fit all patients. However, there are certain definite proportions of proteins, fats, and carbohydrates which can be taken as a standard and then the amounts varied as seems best. I am in the habit of telling my patients that I want them to eat the least amount of food on which they can gain weight satisfactorily. Such a policy does not impair the digestive system, nor does it in any way overburden the kidneys.

"Dr. Goodbody, Dr. Bardswell, and Mr. Chapman[5] made a careful study of the effect of various amounts of food upon tuberculous patients, and endeavored to put the feeding of such patients upon a scientific basis. Their observations were made upon six patients. The amount of food consumed was carefully determined by first weighing the amounts served, and then also weighing any portions that were left uneaten. The urine and feces were carefully collected, weighed and analyzed in order to show the amount of food retained.

"These patients were tested on an ordinary dietary, then one a little more liberal, and, finally, a much more liberal one. Their results show that the most suitable daily dietary consists of about—

4¼ ounces of proteins
5 ounces of fat
10½ ounces of carbohydrates

"An objection might be raised to this suggested dietary that the number of cases is too small; and, it might also be said against its adoption as a general measure that patients of different character and from different walks of life and under different climatic conditions would show different results. It would be profitable to have similar experiments made upon a larger number of patients of different environments, suffering from various forms of the disease, in widely scattered localities, to see if there would be any great variation from the above.

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[4] Loc. cit.
[5] Medico-Chirurgical Transactions, vol. lxxxiv, 1902.

"It is interesting to compare this with what is considered a standard dietary for a man at moderate work. According to Voit such a man should consume about—

4	ounces of proteins
2	ounces of fat
16	ounces of carbohydrates

"Burton Fanning,[6] in an admirable discussion of the subject of diet, quotes the above experiments approvingly, and gives the following as a standard dietary:

		APPROXIMATE VALUE	
		Protein	Fat
Meat	5 ounces	1 oz.	1½ oz.
Milk	3 pints	2 oz.	2½ oz.
1 egg	2 oz.	¼ oz.	⅕ oz.
Porridge	Plateful	⅓ oz.	
Bread	8 oz.	1 oz.	
Butter	2 oz.	trace	1½ oz.
Potatoes, etc	4 oz.		
Puddings	Plateful		
	Total, about	4¼ oz.	4½ oz.

"The items of the dietary are thus distributed for the day:

Breakfast.		
	Porridge, or bread and milk	
	1 egg, bacon or ham, or fish or brawn, etc.	1 oz.
	Bread. Butter	½ oz.
	Tea, coffee, or cocoa........Milk	½ pint.
11 A. M.		
	Milk	½ pint.
Lunch.		
	Meat	2 oz.
	Bread, vegetables, puddings.....Milk	½ pint.
Tea.		
	Tea, coffee, or cocoa........Milk	½ pint.
	Bread, biscuits, etc. Butter	1 oz.

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[6] The Open Air Treatment of Pulmonary Tuberculosis, 1905.

Supper.

Meat	2 oz.
Bread, vegetables, pudding, butter	½ oz.
Milk	½ pint.

Bed-time, or on waking in the morning.

Milk	½ pint.

"It is far preferable to give all the food at the regular meal hours and allow the stomach to rest between. Only in the rarest instances is it necessary to feed between meals.

Fanning also quotes the standard dietary from Mundesley Sanatorium which was supplied to him by Dr. Bardswell and is as follows:

Breakfast.

Coffee or cocoa, made with milk	1 pint.
Toast or bread	3 ounces.
Butter	1 oz.
1 egg, bacon, fish, or tongue	1 oz.
Marmalade	1 oz.

Lunch.

Meat	2 oz.
Fish	2 oz.
Bread	2 oz.
Milk pudding	5 oz.
Butter	⅓ oz.
Cheese and biscuits........Milk	½ pint.

Dinner.

Same as lunch.

"The value of this dietary is:

Proteins	Fats	Carbohydrates	Calories
120 grams	110.	240	2.500"

The caloric needs of the body as worked out by physiologists and clinicians vary as is evident from the nature of the case; yet all agree sufficiently to afford a good working basis. It must be understood, however, that a standard diet is only a relative matter because it varies with climatic conditions, the different conditions under which people work, and in fact, the natural physiological conditions of the patient himself.

The food requirements are expressed in terms of heat units or calories. A calorie is that amount of heat required to raise one kilogram of water one centigrade degree.

Foods belonging to the three classes, proteins, fats, and carbohydrates vary in their heat producing properties or in their caloric values. Fat has the highest caloric value. One gram of fat produces 9.3 calories, while the same quantity of protein or carbohydrate food will produce 4.1 calories.

Moritz[7] shows that the following number of calories per kilo. of body weight should be furnished in the daily dietary of an adult of average nutrition and size.

	CALORIES
Resting in bed	30-34
Quiet out of bed	34-40
Moderate work	40-45
Hard work	45-60

If we apply this to an individual weighing 60 kilos or 130 pounds, he would require,

	CALORIES
Resting in bed	1800—2000
Quiet out of bed	2000—2400
Moderate work	2400—2700
Hard work	2700—3600

In order to furnish the necessary calories it would require, if the patient was eating one type of food exclusively, the following amounts per day:

	FATS	PROTEIN AND CARBOHYDRATES
Resting in bed	190—200 grams	440—500 grams
Quiet out of bed	220—250 "	500—590 "
Moderate work	250—290 "	590—660 "
Hard work	290—390 "	660—880 "

Tuberculous patients who are in the open air can take care of a fairly liberal diet even though they are at rest. A diet suited to the man in moderate work containing from 2400 to 2700 calories is a fairly satisfactory diet for the tuberculous patient of the above average weight of 130 pounds. This can be increased at times temporarily if the patient is not gaining satisfactorily and can be reduced if the patient will maintain himself satisfactorily on less.

The following tables show approximately the amounts of protein, fat and carbohydrate in the foods most commonly used and will aid one in forming an idea of the actual food values of different common articles of diet:

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[7] Quoted by Hewlett in Krehl's Clinical Pathology, J. B. Lippincott Company, Philadelphia, 1907.

FOOD VALUES OF COMMON MEAT AND MILK PRODUCTS

	PROTEIN PER CENT	FAT PER CENT
Bacon	10	60
Beef	30—50	15—30
Cheese	20—35	20—35
Chicken	15	1
Clams	1	3
Crabs	7	1
Eggs	13	9
Fish	10	1—10
Goose	10	33
Ham	20	30
Lamb	15—18	15—25
Lobster	5	1

	PROTEIN PER CENT	FAT PER CENT	CARB. PER CENT
Milk	3	4	5
Mutton	12—18	20—35	
Oysters	7	2	
Pork	10—18	20—35	
Sausage	12—20	20—40	
Turkey	15	18	
Veal	15—20	5—10	

FOOD VALUES OF COMMONLY USED FRUITS

	PROTEIN PER CENT	CARBOHYDRATES PER CENT	CELLULOSE PER CENT
Apples	.5	12	2.5
Apricots	1	12	
Bananas	1.5	23	trace
Blackberries	1	2	5
Cherries	1	10	4
Cranberries	.5	4	6
Figs	5.5	60	7
Grapes	1	15	2.5
Gooseberries	.5	9	3
Melons	.5	7	1
Oranges	.1	9	1.5
Pineapple	.5	10	
Pears	1.5	11	3
Peaches	.5	6	3.5
Plums	1.	15	4
Prunes	2.5	66	1.5
Raisins	2.5	75	
Raspberries	1	5	7
Strawberries	1	6	2

Food Value of Commonly Used Cereals

	PROTEIN PER CENT	FAT PER CENT	CARBOHYDDRATES PER CENT	CELLULOSE PER CENT
Barley Meal	10	2	70	1.8
Buckwheat	7	1	75	.6
Cornmeal	8	5	70	1.5
Oatmeal	14	7	65	3.5
Rye Flour (coarse)	15	2	65	2
Rye Flour (fine)	7	1	80	
Wheat Flour	10	1	75	.7

Percentage of Carbohydrates in the Commonly Used Vegetables

5% OR LESS	10%	15%	20%
Lettuce	Onions	Green peas	Potatoes
Spinach	Squash	Parsnips	Baked beans
String beans	Turnips	Lima beans	Green corn
Celery	Carrots	Apples	Boiled rice
Asparagus	Beets	Pears	Macaroni
Brussels sprouts	Mushrooms	Apricots	Plums
Ripe olives	Lemons	Cherries	Bananas
Grape fruit	Oranges	Currants	Almonds
Cauliflower	Cranberries	Raspberries	
Tomatoes	Blackberries	Pecans	
Rhubarb	Strawberries	Filberts	
Egg plant	Peaches	Walnuts	
Clams	Pineapples		
	Watermelon		
	Muskmelon		

Inasmuch as fat is quite an important article of diet in the food of the tuberculous, the following table representing the percentages of fats in articles of food which are commonly used, is of value:

Food Value of Commonly Used Fats

Bacon	65%
Beef	15—30%
Butter	85%
Nuts	30%
Oatmeal	7.1%
Olives (ripe)	25%
Olives (green)	13%
Pork	80%

In order to afford a workable basis for carrying out the proper feeding, the table compiled showing the value of common household measures and sold by Franklin W. White, M.B., of Boston, is especially convenient. This table is reproduced on pages 322 and 323.

The body may be maintained for a time by any single one of the classes of foods used alone, provided it is administered in sufficient quantity; but such a method of feeding is not advantageous, neither from the standpoint of food provided, nor of the body economy; for much more elaborate processes must be carried on to adapt such a one-sided dietary to the various body needs than are necessary when all classes of food are administered.

In tuberculosis, the wasting which first takes place is in the less important structures, the stored fat and the muscles; while the more important tissues do not waste until later.

Fat can best be stored up by eating fat and carbohydrates. These are also the chief fuel ingredients of food. Protein builds the tissues of the body, but when fat and carbohydrates are not furnished or are furnished in amounts below the requirements of the body, proteins can be transformed into energy; so, while a combination of all classes of food is best for the organism, yet each can directly, or indirectly, act for the other and meet the requirements of the body, at least for a time. When we consider the demands which are made upon the body of the tuberculous patient, at least after he reaches the stage of necrosis and wasting, it would seem that his requirements for protein are above normal; and when we consider the loss of adipose tissue that takes place we might also add, with reason, an extra amount of fat to the dietary. In the early stages, however, I cannot believe that the requirements of the tuberculous differ greatly, if at all, from the requirements of the same individual in health.

The amount of food consumed by an individual differs materially according to the conditions under which he lives and according to the amount of work which he performs. It has been estimated that from 2000 to 2500 calories a day are necessary for a man who is not working, while 4000 a day are required for a man doing heavy muscular work. Heavy muscular work increases oxydation and burns up tissue which must be supplied from the food eaten. In treatment of the tuberculous patient he is put under hygienic conditions in the open air and in this

Foods as Eaten	Actual Amount	Household Measure	Approximate			
			Calories	Grams		
				Protein	Fat	Carbo-hydrate
DAIRY—Milk	8 oz.	a glass	160	7.5	9.5	12.
Skimmed milk and buttermilk	8 oz.	a glass	80	7.5	1.	11.5
Cream thin (20 per cent)	16 gms.	a tablespoonful	30	.5	3.	.5
thick (40 per cent)		a tablespoonful	60	.5	6.	.5
Condensed Milk Sweetened	20 gms.	a heaping teaspoonful	70	2.	2.	11.5
Unsweetened		a heaping teaspoonful	35	2.	2.	2.5
Butter	10 gms.	a pat or ball	80		8.5	
Cheese Cream	15 gms.	one inch cube	65	4.	5.	.5
Skim-milk		one inch cube	45	4.5	2.5	.5
American		one inch cube	70	4.	5.5	
Eggs, whole	50 gms.	one	75	6.5	5.	
Eggs, yolk	15 gms.	one	55	2.5	5.	
Eggs, scrambled	40 gms.	a heaping tablespoon	45	4.	3.	.5
MEAT AND FISH (cooked)						
Beef tea, clear soups	5 oz.	a teacup	5–20	1.–4.5		.5
Fish Lean (cod, flounder)	50 gms.	a heaping tablespoon	35	8.5		
Fat (shad, salmon)		a heaping tablespoon	105	11.	6.5	
Meat Lean	50 gms.	a medium slice	70	11.5	2.5	
Medium Fat		5 x 3 x ¼ inch	130	11.5	9.	
Fat			200	8.5	18.	
Lamb chops (edible portion)	45 gms.	a medium	165	9.5	13.5	
Oysters, medium size (raw)	16 gms.	one	8	1.	.2	.5
CEREALS & VEGETABLES (cooked)						
Bread, white or graham	25 gms.	one slice 4 x 4 x ⅓ inch	70	2.3	.5	13.
Vienna roll	40 gms.	one	115	3.5	1.	22.5
Crackers (Uneeda)	7 gms.	one	30	.5	.5	5.
Cereals (cooked moist)	40 gms.	a heaping tablespoon	35	1.		7.
Cereals (eaten dry)	5 gms.	a heaping tablespoon	20	.3		4.
Shredded Wheat	30 gms.	one	110	3.	.5	23.
Gruels (cereal)	8 ozs.	a soup plate	75	2.5	1.	14.

Foods as Eaten	Actual Amount	Household Measure	Approximate			
			Calories	Grams		
				Protein	Fat	Carbo-hydrate
CEREALS & VEG'T'ES.—Contd.						
Thickened or cream soups	8 ozs.	a soup plate	160	5.5	4.5	24.
Macaroni	25 gms.	a heaping tablespoon	25	1.	.5	4.
Potato, boiled or baked	95 gms.	one medium	90	2.		20.
Potato, mashed	35 gms.	a heaping tablespoon	40	1.	1.	6.
Rice, boiled	30 gms.	a heaping tablespoon	35	1.		7.
Corn, canned	35 gms.	a heaping tablespoon	35	1.	.5	6.5
Peas, fresh	35 gms.	a heaping tablespoon	40	2.5	1.	5.
Lima beans	25 gms.	a heaping tablespoon	20	1.		3.5
Squash	35 gms.	a heaping tablespoon	20	.5		3.5
FRUITS—Apple, pear	120 gms.	one medium size	75	.5	.5	17.
Apple sauce	45 gms.	a heaping tablespoon	70		.5	16.5
Banana	100 gms.	one medium size	100	1.5	.5	22.
Orange	130 gms.	one medium size	70	1.		15.
Grape Fruit	80 gms.	one-half small	35	.5		8.
Strawberries	100 gms.	a medium saucerful	40	1.	.5	7.5
Dried figs, dates, raisins	100 gms.	a medium saucerful	350	2.5	3.	76.
Fruit jelly, sweetened	50 gms.	a heaping tablespoon	160	.5		38.5
DESSERTS—Custard	40 gms.	a heaping tablespoon	55	2.5	.5	9.
Ice Cream	40 gms.	a heaping tablespoon	135	1.5	9.	11.
Sponge Cake	20 gms.	a slice 2 x 4 x ½ inch	75	1.5	2.	13.
Pudding (rice, tapioca, bread)	45 gms.	a heaping tablespoon	80	2.	2.	13.
ALCOHOL	12 gms.	a tablespoon	85			
Whiskey, brandy, etc. (50 %)	1 oz.	a small wineglass	85			
Wines (8 – 25 %)	1 oz.	a small wineglass	15 – 50			
MISCELLANEOUS—Sugar	8 gms.	a heaping teaspoon	33			8.
Honey, marmalade	10 gms.	a heaping teaspoon	33			8.
Olive Oil	4 gms.	a teaspoon	37		4.	
Olives	7 gms.	one medium size	15		1.5	.5
Almonds, shelled	25 gms.	a heaping tablespoon	165	5.	13.5	4.5
Cocoa powders	10 gms.	a heaping teaspoon	50	2.	3.	3.5

way the oxidation processes in the body are increased. This enables him to eat amounts of food somewhat larger than he would be able to eat if he were living under different surroundings. It is a common experience to notice an increase in the appetite of patients as well as healthy individuals when put in the open air. The average patient suffering from tuberculosis, when placed in the open air under hygienic conditions will consume with relish, considerably more food than the same individual when living under his usual surroundings. The patient, however, while kept at rest, must not eat as large quantities as when exercising. If too large quantities of food are consumed, fat will be stored up, yet the nutrition of the patient may not be improved. It also causes disturbances on the part of the gastrointestinal tract. The amount of food must also be adjusted to climatic conditions. Most of the food consumed is for the purpose of maintaining body heat, therefore it is evident that the amount consumed must differ according to the temperature of the atmosphere in which the patient lives. In institutions where many patients are under observation the effect of changes in temperature are easily studied. If the weather is cool, large demands are made on the body for heat; the patient's appetite is accordingly keen and calls for large quantities of food. If this is followed by a sudden spell of warm weather the patient's appetite is apt to lag and unless the amount of food consumed is reduced, he will suffer from digestive disturbances. This is nature's way of telling an individual that he does not require as much food for warm weather as he does for cool weather. A great many disturbances can be avoided during the warm weather by instructing patients to cut down their diet when decided rises in atmospheric temperature occur. This effect of weather conditions upon metabolism and the demand for food is not sufficiently understood and appreciated in practice.

The Limitations of Raw Eggs as a Food.—Raw eggs in large quantities have been used for a number of years in the treatment of patients suffering from tuberculosis; in fact, the first thing suggested to patients suffering from tuberculosis was the consumption of large quantities of milk and raw eggs. Many of us were early convinced of the fact that it was not altogether harmless, and, in many cases was more or less prejudicial to the progress of the patient. Bearing upon this subject, the recent work of Bateman[8] is of great interest.

This work shows what many of us have noted clinically, that consumption of large amounts of raw eggs is followed in many instances by disturbances on the part of the gastrointestinal tract with symptoms of colitis; and, sooner or later, by distress on the part of the patient. Bateman shows that in rats, dogs and man, himself, diarrhea may be produced by the consumption of large quantities of raw egg white. He also shows that raw egg white is not absorbed readily by the alimentary canal. I quote from his work as follows:

"Experiments were made with native egg white and raw eggs upon a number of persons, and the cooperation of still others who were eating raw eggs in order to gain weight was secured. The data collected confirmed the points already brought out. Most of the subjects experienced diarrhea which generally abated after several days' ingestion of the raw foodstuff, and many complained of intestinal discomfort. The material was poorly utilized. These experiments will be discussed more in detail together with the question of the use of raw eggs in practical dietetics, in another place.

"The results of these experiments are in accord with those of other investigators. Falta (1906) found raw egg white to be utilized by man to the extent of 70 per cent. A still lower value, 50 per cent, was reported by Wolf (1912), who has described the peculiar behavior of this foodstuff when ingested by man. He did not observe diarrhea, but the feces were of soft consistency. When raw egg white was in the diet there was over twice as much nitrogen in the feces as when the food contained the same quantity of nitrogen in the form of other proteins. On one occasion the feces contained more nitrogen than did the urine. The latter did not contain albumin, a result in contrast to those of Hamburger (1902) and Cramer (1908) who claimed that albuminuria followed the ingestion of large doses of native egg white by man. Previously Oertel (1883) had not been able to find albuminuria in the urine in such cases, and neither did uncooked egg white cause an increase in excreted albumin in preexisting albuminuria. Wolf also noted that when either raw or cooked egg white was superimposed upon a standard diet there was a delay in the excretion of nitrogen and sulfur, the delay being greater in the sulfur elimination. He suggested that the sulfur complexes in the uncoagulated egg white have considerable power to withstand the action of the digestive enzymes.''

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[8] The Digestibility and Utilization of Egg Proteins, Journal of Biological Chemistry, August, 1916, vol. xxvi, No. 1.

It can be seen that while raw egg white was not readily utilized, cooked egg was utilized almost fully. Bateman sums up his observations as follows:

''Raw egg white is found to be a decidedly indigestible substance. It may cause diarrhea in dogs, rats, rabbits, and man when ingested in any large quantity. Its utilization by the body is poor since it is used only to the extent of 50 to 70 per cent. Subjects can acquire a certain tolerance for the native protein after ingesting it for several days so that it no longer causes diarrhea and is somewhat better utilized.

''Raw egg white can be made digestible through coagulation by heat; by precipitation with alcohol, chloroform, or ether; by incubation with dilute acids or alkalies; by partial digestion by pepsin; by conversion into alkali-metaprotein.

''The indigestibility of native egg white probably lies either in its antitryptic content or in its chemical constitution. Its physical texture appears to play a minor part in its behavior.

''Of the individual proteins constituting egg white, the albumin fraction appears to be the indigestible component.

''The whites of the hen's egg and duck's egg act alike in causing diarrhea, and in being poorly utilized.

''Egg yolk either raw or cooked is excellently utilized. It sometimes causes digestive disturbances in dogs, apparently because of its high fat content.

''A review of the literature shows that dietitians have relied, in general, upon the early observations of Beaumont as support for the use of raw eggs. These observations were in the main exact; but, so far as the digestibility of raw egg white is concerned, were misinterpreted.

''In current dietotherapy raw whole eggs, raw egg white, and albumin-water are extensively prescribed. There appears to be little in their conduct of foodstuffs, however, to warrant such faith in their nutritive value or ease of assimilation.''

Suiting the Food to the Digestive Powers of the Patient.—In this connection it is necessary to have as definite an idea as possible of the digestive capacity of the patient. If the patient has hypochlorhydria he will require a very different diet from one with hyperchlorhydria. If he has intestinal stasis he must have food suited to it. If he is suffering from constipation of the atonic variety he must have a different dietary from that required if he has constipation of the spastic variety; so, the dietitian must not only consider what the patient with tuberculosis should eat, but he must consider what the patient with tuberculosis, who may have any of the organic or functional derangements of the gastrointestinal tract, may eat, and suit his diet to the particular condition to be coped with.

Relation of the Body Cells to Nutrition in Tuberculosis.—Not only is it necessary to take into consideration the condition of the gastrointestinal tract and the food eaten, but we must consider the state of the body cells in their relationship to nutrition. Let us conceive that a diet might be properly balanced and might be properly digested, yet the blood might not be in a condition, either because of changes in its quality or changes in its movement in the body, to carry the elements of nutrition to the body cells, and the body cells themselves might not be in proper condition to receive the food when carried to them; or, if we look at the other side of the picture, the blood might be hindered in ridding the body of the various waste products. There might be difficulty either in carrying the waste products from the body cells, or the cells of the excretory organs might be in such a condition that they could not eliminate the matter brought to them. Under any of these conditions nutrition suffers. The effect of toxemia in tuberculosis is seen on all the tissues of the body. Its effect upon nutrition is very marked. Such symptoms as fever, night sweats, malaise, lack of endurance, nervous irritability, increased pulse rate are everyone expressions of toxemia and exert an inhibiting action upon the cellular activity of the organism. The effect is further shown in its interference with metabolism, the loss of fat and muscle substance and the changes in the blood. The degree of toxemia depends upon the virulence of the bacilli, the length and extent of the destructive process.

As a result of tuberculosis we have two very important cell degenerations in the various organs, amyloid and fatty; both of which are produced largely by stimulation of nerve cells, by the action of the toxins, and the malnutrition which results from the disease. To be more specific it is probable that pathologic degeneration has back of it as its cause trophic disturbances which are produced by chronic nerve stimulation and chronic changes in the chemical stimulants furnished by the glands of the internal secretions.

The Effect of Abnormal Action on the Part of the Respiratory, Circulatory and Nervous Systems Upon Nutrition.—These very important subjects do not require extensive treatment in this place as they have been discussed elsewhere. It is self-evident that the serious disturbances on the part of the respiratory system which result from the diminution in lung area alone must interfere with the proper oxidation of the blood and disturb nutrition. The same may be said of the circulatory system. If the circulatory system is embarrassed, or if it fails in its action, and is unable to propel the blood properly through the body tissues, the effect of this is felt upon cell metabolism; and nutrition suffers. The effect of nervous impulses upon the gastrointestinal tract have been mentioned above, but such influences are not confined to any one system of the body, but extend to every important function of the body. On this account the disturbance in nerve balance produced by tuberculous toxemia has a profound effect upon nutrition.

Vitamines.—A most important contribution to the subject of dietetics recently has been made by McCollum.[9] He has shown that there are two substances found in foods which are indispensable to growth and development. One of these, he calls Fat soluble A. This is found in butter fat, egg yolk and glandular organs; the other, Water soluble B, is found in the leaves of plants, with this knowledge, milk, eggs, and such plants as spinach, lettuce, cabbage and other leafy plants assume great importance in the diet for the tuberculous. Some of these should be included in all such dietaries.

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[9] The Newer Knowledge of Nutrition, New York, 1919, Macmillan Company.

CHAPTER XL.

TUBERCULIN.

What is Tuberculin?—The term "tuberculin" is used to designate a number of different products made from the tubercle bacillus. These products differ from each other in their method of production, hence in their content of bacillary substance. Individual preparations also differ as compared with each other when grown on different media, and produced by different strains of the tubercle bacillus. They all contain substances derived from the tubercle bacillus and depend upon this fact for their specific action.

There is an objection to applying the term "tuberculin" to all bacillary products. It would be more accurate to speak of them as tubercle bacillary products, or tubercle vaccines, and reserve the name tuberculin for Koch's original preparation to which he gave this name; but, inasmuch as the name has been applied indiscriminately to all preparations made from the tubercle bacillus, I will retain the term in my discussion.

There is much unnecessary confusion as to what tuberculin is. Owing to the fact that it is capable of producing severe clinical symptoms in patients or animals who are already tuberculous, it has been looked upon by some as being a poison; but this statement requires to be qualified. It is a poison in the strict scientific sense that all bacillary protein is capable of producing poisonous effects; and, in the sense that it is capable of producing anaphylactic symptoms when introduced into a patient infected with tuberculosis, the same as any protein when injected into an individual or animal sensitized to it. Its action, however, differs according to whether the patient is already tuberculous or not. The newborn child, or the healthy guinea pig, may be given comparatively large doses of tuberculin without producing either toxic or sensitizing symptoms. After infection has occurred, however, comparatively small doses may produce either action, probably because the protein molecule is rapidly split up by the specific defensive bodies liberating both toxic and sensitizing substances, to cause reaction. Tuberculin, then, is toxic, only in the sense that any other foreign protein is toxic,—that is, when administered in large doses or when administered to an individual, or animal, whose cells have previously acquired the property of producing specific defense.

A great deal of the discussion of tuberculin shows that it is quite generally believed that in treating tuberculosis with tuberculin one is using something wholly foreign to the patient. The fact does not seem to be sufficiently understood that every patient who has tuberculosis is constantly setting free, within his body, bacillary substances similar to those which are found in the tuberculin made from the tubercle bacillus, cultivated artificially. Furthermore, it is not sufficiently understood that tuberculosis heals only because of the fact that these products of the tubercle bacillus are set free to stimulate the body cells to the production of specific defense and incidentally to stimulate the focus of infection and hasten the production of fibrous tissue.

No tuberculous patient would get well of an infection were it not for the specific stimulation produced by the bacillary protein from his tuberculous foci. The protective action of these bacillary products is two-fold, as I shall now discuss. The first and most important action is that of producing an immunity whereby the spread of the disease is hindered or prevented. This is particularly important early, while the infection is slight. The fact that clinical tuberculosis has always been attended by so high a mortality, has created the belief that the tubercle bacillus does not produce an immunity against itself. While this statement does not receive sanction from students of immunology, yet the belief is quite common among laymen and physicians, who have given little attention to the study. The contrary is true. The tuberculous individual develops a very high grade of immunity. His body cells are stimulated to the production of specific defense to such a degree that inoculations of large numbers of tubercle bacilli may be destroyed without an infection resulting. This is evident from the clinical experience that patients may have an extensive infection and yet regain health. We cannot look upon this immunity as being other than relative, however, for if the reinoculation is produced by a sufficient number of bacilli, the specific defense is overcome and infection results. Tuberculosis, particularly the ulcerative form, which is extremely common, shows a constant tendency to spread. Bacilli escape from the foci in which they develop, into adjacent tissues and there either meet destruction or set up foci of infection. If new metastases should occur every time that bacilli make their escape, there would be little chance of any individual overcoming his infection; but clinical experience shows that many of these patients do get well, in spite of widespread infections. They can only do so because the patient is well guarded by his protective defenses, of which the specific defense is probably the most important. Furthermore, clinical observation shows that the patient may have advanced tuberculosis in any organ and throw off bacilli through natural channels without new metastases occurring. This could not be were the cells lining these channels not provided with extraordinary defense. This is particularly evident in the bronchi and throat where millions of bacilli pass over the mucous membranes daily, being thrown off from the ulcerated foci in the lung. These infected discharges often pass over these mucous membranes for months, and sometimes for years, without causing infection; large numbers of bacilli are also swallowed; and, yet, this process continues for many years without infection of the bowel occurring; although the bacilli are able to pass through the stomach uninjured by the gastric secretion. When infection does occur, the character which the process assumes is also proof of the fact that immunity, or specific tissue resistance, is present. As discussed elsewhere in these pages (Volume I, Chapter III), prior to the time that infection occurs, tubercle bacilli pass through the tissues without being hindered, except by the natural defensive processes, such as are found in the lymph and plasma; and, the phagocytic action of the cells. After infection has occurred, however, the picture is entirely different; bacilli no longer pass readily through the tissues, but are detained in passage. A specific inflammatory reaction takes place between the bacilli and the tissue cells at the point of implantation. As a result of this specific reaction the bacilli are destroyed, or, if they are not destroyed and a local focus of infection forms, this is followed by an encapsulation of the bacilli or an ulceration. This must be looked upon as an attempt to localize and discharge the invading bacilli. These are strong evidences of an immunity in tuberculosis; and this immunity cannot be produced except as a result of stimulation of the body cells by the products which are formed during the growth of the tubercle bacillus, or by the products which result from the destruction of bacillary products which gain entrance to the body tissues.

The second action of the bacillary products is particularly important in healing tuberculous foci. This depends upon the property which the bacillary products possess of being able to set up an inflammatory reaction when they come in contact with specific proteolytic enzymes which are elaborated by the body cells. The splitting up of the bacillary products preparatory to rendering them harmless and discharging them from the system is carried on by these specific proteolytic enzymes.

In our explanation of the focal reaction, we must not lose sight of the fact that there are probably specific immunizing bodies which circulate in the body fluids, as well as those which are joined with the body cells (sessile), so we must also conceive that probably the circulating antibodies have an effect in producing the focal reaction. The focal reaction could well be produced by circulating antibodies coming in contact with bacillary products which emanate from the focus of infection itself, or by specific bacillary products circulating in the blood and coming in contact with the sessile receptors of the fixed cells at or near the focus. This specific focal stimulation, if of a slight degree, shows as a mild hyperemia; but, if of a severe degree, the hyperemia is more marked, and even congestion may result. If the focal reaction is marked, this congestion may even result in an exudation, and the more severe pathological changes which are common in tuberculosis. The beneficial effect of this hyperemia comes through its stimulating effect upon the cells surrounding the focus of infection, from which new tissue formation results and healing is hastened.

These specific reactions are essential to the healing of tuberculosis. As there could be no tuberculosis without the living tubercle bacillus, so there could be no specific immunity to tuberculosis and no great amount of healing of tuberculosis without the stimulation of the body cells by the bacillary products which arise from the tubercle bacillus.

This description of the method in which the bacillary products from the focus of infection act, also explains how the various artificial bacillary products produce their beneficial effect. Tuberculin is an artificial product made from the tubercle bacillus, and, as such, stimulates the body cells to the development of specific defense and to the formation of specific enzymes, which tend to destroy similar bacillary products when found, no matter from what source. Could we make our tuberculins from tubercle bacilli grown upon the tissues of the individual to be treated, and could we make a preparation which would contain all of the various bacillary products in proper proportion, I do not doubt that we could attain a highly immunizing product; but, inasmuch as this has so far proved to be unattainable, we must realize that our artificial products lack some of the properties which are greatly desired in them. We are further led to believe that the action of the usually employed tuberculins is not as great in the production of immunity against the tubercle bacillus, as it is in producing focal stimulation and hastening fibrosis. Tuberculin will produce focal stimulation when injected therapeutically. This is proof of its specific action.

Experiments on Animals Not Conclusive as to the Action of Tuberculin.—Many opponents of tuberculin have put forth as an argument against it that inasmuch as it does not regularly immunize guinea pigs against tuberculosis, and inasmuch as it does not regularly cure tuberculosis in animals, it is of no value in the therapeutics of clinical tuberculosis in man. This claim requires attention because it is put forth by many able men.

From my preceding discussion, it can be seen that this claim has no weight, even if both statements were true. No matter how ardent a believer one is in the utility of tuberculin as a therapeutic measure, he must admit that marked immunity against the tubercle bacillus cannot be regularly produced in animals by the use of tuberculin. The production of this condition can only be counted on regularly by the action of the living tubercle bacillus. There have been a sufficient number of observers, however, who have reported a high degree of resistance to the tubercle bacillus, as being produced by the parenteral injection of bacillary products, to show that it is possible to raise the specific resistance of the animal by these products. There have been a few instances reported where a very high degree of immunity has been attained. These cases, however, must be looked upon as being accidental, because they do not occur regularly. It requires for the regular production of immunity that the entire bacillus be employed; and, in fact, the living bacillus seems to be necessary to regularly produce a marked degree of immunity against itself; consequently, we are led to suggest that in those cases where an exceptionally high degree of specific defense has been attained, that the preparation of tuberculin used in producing the immunity happened to contain the various bacillary products derived from the tubercle bacillus in such proportions as are necessary to increase the cellular resistance to all of the important substances contained in the living bacillus. Sensitization of the body cells has also been produced by the injection of tubercle protein, which shows that it has the power of producing the immune state.

I desire further to call attention to another weakness in the above argument; namely, that guinea pigs and other small animals used in these experiments, have not had an opportunity to build up a specific cellular defense by long contact with the bacillus and bacillary products. The human being, on the other hand, is endowed at birth, with a racial immunity which has developed as a result of previous centuries of living in contact with the tubercle bacillus. He further develops his tuberculous infection, at least the type which we attempt to treat with tuberculin, for the most part, after long contact with the tubercle bacillus. His cells have received stimulation from bacillary products, as a rule, over a period of years and have developed the property of producing specific protective substances in large numbers; consequently, when tuberculin is injected into a human being as a therapeutic measure, we are treating a patient whose cells possess a high degree of specific defense, and are capable of giving marked focal reactions, which, as I have mentioned before, are exceedingly beneficial in their curative effects.

The fact that tuberculin when introduced into an individual who is infected with tuberculosis, produces a reaction on coming in contact with the tissue cells, shows that it is capable of forming an inflammatory reaction with the specific proteolytic ferments formed by the cells when stimulated by the bacillus in natural infections; and, further, warrants the assumption that any stimulation which it might produce in the cells causing the formation of specific protective substances might likewise be active against the bacillus.

The small animal dies of his tuberculosis before he is able to produce a high degree of specific defense. A tuberculous infection in such an animal must be considered the same as a tuberculous infection in virgin soil; such as is found in the negro fresh from Africa, the inhabitants of Iceland, prior to their coming in contact with people from the outside world who carried infection to them, and the American Indians prior to the advent of the white man. These people have not inherited a defense against the disease by the long contact of their ancestors and have no specific resistance within their bodies; consequently, when infected, they die of acute tuberculosis. This same thing is noted in our experimental animals; consequently, it is wrong to draw conclusions from this type of tuberculosis and apply them to the chronic form of human tuberculosis, which is particularly suitable for tuberculin therapy. Even in human beings we are not able to produce results by tuberculin in the acute forms of the disease, and we now assume that tuberculosis takes the acute forms which it often does, particularly because of a relatively low defense, as compared with the degree of infection.

Artificial Immunization.—It is a cherished hope on the part of all who are interested in the prevention of tuberculosis, that some method of artificial immunization may be found. Among many workers, the names of Koch, von Behring, Spengler, Much, Calmette, Maragliano, in Europe; and Trudeau, Baldwin, Pearson, von Ruck, and Webb, in America have been closely associated with studies on active and passive immunization. So far no remedy which fully satisfies the demands of a complete immunizing agent has been found; yet preparations with marked immunizing properties have been attained. The work of Maragliano in producing a localized skin lesion has been in use in the Genoa Clinic for several years. Webb's experience with living bacilli, beginning with a single bacillus and increasing gradually is extremely interesting, but so far has not proved practical. Much and von Ruck have been working from different viewpoints, yet their ideas have many points in common. Both report marked immunizing effects on animals as well as human beings. These effects demand sympathetic as well as critical analysis, for they represent labors in the most difficult field of medical research. While these pioneers may not find the preparation desired, let us hope that their labors may pave the way for a complete immunizing or curative agent.

The Tuberculin Reaction.—Through the many studies of Koch, von Behring, von Pirquet, Wolff-Eisner, Römer, Friedberger, Vaughan, Baldwin, Austrian, Krause, and others, we have accumulated a sufficient number of important observations to enable us to form a fairly intelligent idea of the tuberculin reaction. At the same time, there are still many questions which cannot yet be answered. The action of tuberculin in the tuberculous patient is different from that in the non-tuberculous individual. The tuberculous patient is already sensitized. His body cells already possess the power of defending him against further attacks of the tubercle bacillus and incidentally of destroying any and all bacillary substances which gain access to the tissues.

Tubercle vaccines contain tubercle protein and other substances from the tubercle bacillus. Tubercle protein must be considered as an antigen because it has the power to produce antibodies. Lipoids, like protein, also have this power of producing antibodies, and, consequently, must also be considered as antigens. These two substances are found in the various tubercle vaccines in varying quantities. When tuberculin is introduced into the body we must consider that a preparation is being introduced which contains either protein or lipoids, or both, made from the tubercle bacillus; and, as such, they meet the body cells which are already endowed with the power of producing specific enzymes against these substances of the bacillus. While these substances may differ somewhat from the antigens elaborated in the focus of infection, yet they are sufficiently closely related to them to react to the same specific enzymes. When the body is being periodically, or constantly, stimulated by specific bacillary substances, not only do the cells possess the power to produce specific enzymes, but we must conceive of these bodies being thrown off into the blood stream, resulting in both histogenic and cellular immunity.

When tuberculin is introduced into the body its reaction comes probably as a result of the union with both free antibodies and those which are attached to the cells (sessile). It is not improbable that the character of the reaction, and the degree of the reaction, varies according to the relative part which the attached and free antibodies take in the process.

In tuberculosis, we must consider that all of the cells of the body are sensitized. Tuberculosis is a chronic disease in which, as a rule, tubercle products are thrown out into the blood circulating intermittently over a prolonged period of time; consequently, there is ample opportunity for the cells to take upon themselves the function of producing specific proteolytic enzymes, at a time when the body is in such a state of nutrition that the cells are capable of reacting to their fullest capacity.

The tuberculin reaction results from the combination of the tubercle substances contained in the vaccine employed, and the antibodies, either free or attached, found within the tuberculous patient; but we can only conceive of its occurrence during and after cleavage has taken place when the toxic and sensitizing molecules are being or have been set free to produce their respective reactions.

Vaughan has shown that the toxic product and the sensitizing product of the tubercle protein molecule are different; so we conceive of the immunizing substance which produces the local and focal stimulation, as being different from that which produces toxemia.

General Reaction.—The general reaction in tuberculosis is characterized by the general syndrome of toxemia. It consists of fever, a condition of malaise or aching, lack of appetite, disturbed digestion, increased pulse rate, sometimes chilliness, or even rigor. We formerly considered this as an integral part of the immunity reaction, but I now look upon it as being only an accidental part of the tuberculin reaction. What we have heretofore been describing as a general reaction to tuberculin, we must now consider only as a reaction of the body to the toxic molecule of the tubercle protein which, according to the experiments of Vaughan, has nothing to do with immunization. In this connection, however, we must not lose sight of the fact that the rise in temperature may have an important action in checking bacterial growth when infection is present. There have also been reports which indicate that the rise may favor the increase in antibodies, but this requires further confirmation. The local and focal stimulation, on the other hand, are the important ones, as far as the production of immunity, and as far as the stimulation of the cells about the focus of infection to the production of healing are concerned. These two processes result from the same cause and fail to appear when an inoculation is made in an animal or individual who is not already tuberculous. The action of the toxic molecule is illustrated in Fig. 130, and the subject is further discussed in its relationship to anaphylaxis on page 344.

Local Reaction.—In my discussion of metastatic tuberculosis, in other parts of this monograph, I have shown that those metastases which occur in the human being after infection has existed and sensitization of the body cells has occurred, are very different from the infection which results from the primary inoculation. The phenomena of primary inoculation, and metastatic tuberculosis in an individual already infected, follow the same course as do the inoculation of healthy pigs, and the secondary inoculation in pigs already infected, as first described by Koch, and later studied carefully by Römer.

When bacilli gain entrance into the tissues of an individual who is already infected, the reaction which ensues is the counterpart of the reaction which occurs when tuberculin is thrown into the tissues of an already infected individual. A process is set in motion whereby the bacilli in one case and the tuberculin in another, are split up into simpler substances, preparatory to their destruction. This process of attack is accompanied by an inflammatory reaction which, in the case of the tubercle bacillus, is manifested by pathological changes in the tissues and must be looked upon as an attempt to check the process at the point of invasion. This, at times, results in the total destruction of the bacilli; again, in their encapsulation; at other times, in necrosis of tissue and local ulceration, with expulsion of the tuberculous mass. In the case of tuberculin, on the other hand, no infection can result but an inflammatory proc-

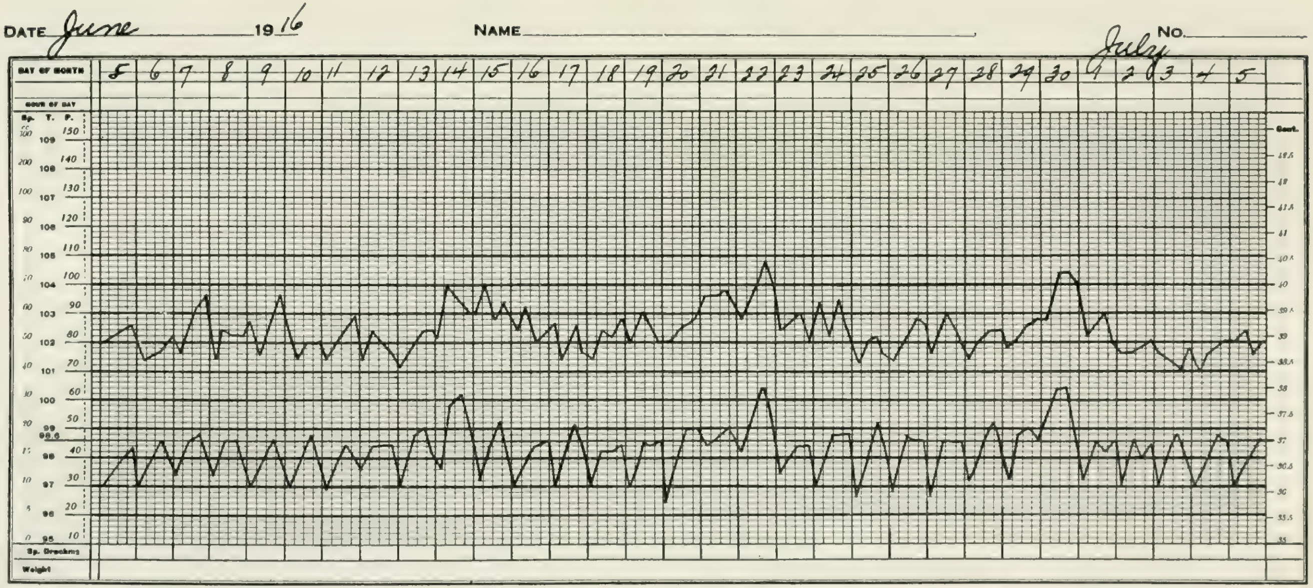

Fig. 130.—Showing three distinct tuberculin reactions one following a dose given on the 13th day of June; another on the 20th of June; and another on the 29th day of June. The curves differ in character, except in one particular: on the morning following the dose the minimum temperature was higher than normal. An interesting feature in this case is that the patient was suffering from asthma. Each time a dose was given, producing toxic reaction, the asthma was relieved slightly.

ess of greater or lesser severity is set up as a result of the specific reaction. This shows as an area of redness, or even a swelling accompanied by heat. Where the tubercle substance (tuberculin) used in artificial inoculation, is an emulsion, however, its elaboration by the defensive properties of the body is often slow, and a nodule remains for a long period of time, from which we are probably correct in assuming that gradual inoculation of bacillary substances takes place.

The Focal Reaction.—The explanation of the focal reaction is not quite so clear as that of the local reaction at the point of inoculation. It seems that it might be accounted for in either one of two ways, as previously mentioned;—first, that the tuberculin in the process of elaboration is broken up into specific sensitizing substances, which gain access to the blood stream, and are strained out in or near the focus of infection, to combine with the antibodies there found; or, second, an increased number of free antibodies might be produced as a result of the injected tuberculin and thrown into the blood stream which, circulating in or near the focus of infection, come in contact with tubercle protein, as it is set free from the focus of infection. Thus we conceive that the focal reaction might be due either to antibodies produced by the tuberculin coming in contact with the antigen produced in the focus of infection; or by the antigen being furnished from the tuberculin and coming in contact with specific protective substances produced by the cells in or near the focus. The focal reaction is a more or less constant accompaniment of tuberculin injections. The degree of reaction depends upon the degree of specific defense present; also considerably upon the amount of tuberculin injected,—not the amount *per se,* but the relative amount of tuberculin as based upon the preceding dose.

In order to produce a focal reaction, it is necessary that the amount of sensitizing substances in the tuberculin given be sufficient, when elaborated by the specific substances in the body, to have a surplus left for circulating in the body fluids, to come in contact with the cells of the focus; or, for producing sufficient free antibodies to circulate and come in contact with the tubercle products in the focus. This may be brought about, either by small injections at infrequent intervals, according to the method suggested by Wright, or the method which attempts to produce a tox-immunity, as followed by other clinical observers.

The tuberculin reaction, then, seems to be a complex process, which arises from a lytic action upon the tubercle molecule, splitting up the bacillary substances into compounds which are less complex and permitting them to produce their respective reactions. In this there seem to be two distinct bodies, as mentioned above,—one of which is sensitizing, or anaphylactic in its action; the other toxic, resulting in the toxic syndrome. The former is definitely connected with the production of bacillary immunity, and healing, while the other produces an accompanying toxic reaction.

The Anaphylactic and Toxic States Contrasted.—Whether the tuberculin reaction is identical with anaphylaxis is as yet uncertain. There is a general belief on the part of such observers as Baldwin, Vaughan and Zinsser that they are identical, yet this cannot be stated as a fact. In order to determine this, it is necessary to study both the phenomena of anaphylaxis and those attendant upon the tuberculin reaction in their entirety. The anaphylactic reaction has almost wholly been studied on animals, particularly the guinea pig, while the tuberculin reaction, for the most part, has been studied on human beings. While it might seem that this would make no difference, yet if one will observe the difference in the symptoms in anaphylaxis, as shown in a guinea pig and a dog, they can draw further conclusions that there might be an equal, or more marked, difference between the lower animals and man.

That the tuberculin reaction, at least partly, and the anaphylactic reaction wholly, are a part of the general immunity reaction, seems certain. The tuberculin reaction is associated with certain phenomena which are not present in the anaphylactic state in lower animals. It seems to me that the tuberculin reaction can be separated into two entirely distinct phenomena,—the one a toxic, and the other a sensitizing reaction. I doubt very much that the toxic reaction is an essential part of the immunity reaction. If it should not be, this would be entirely in accordance with the theory of Vaughan, that the sensitizing and toxic products are different. We must not lose sight of the influence of the increase in body temperature in checking the growth of the bacilli; and probably also in favoring the production of antibodies.

In order to make our meaning clear, we will have to bear in mind that the toxic action is represented by the syndrome of toxemia,—fever, lessened appetite, disturbed digestion, constipation, rapid heart's action, malaise, headache, and general aching, probably preceded by a feeling of chilliness or distinct rigor,—the severity of the symptoms depending upon the degree of the toxemia. These symptoms do not appear commonly, except when a large dose of tuberculin is administered. I mean by a large dose, a dose which is large, as compared with the preceding dose given, and large for the interval which has existed between the administration of the preceding dose and the dose in question.

The signs of sensitization may show anywhere in the body; for example, in the tissues of the skin when tuberculin is introduced, even in small quantities, either by abrasion (von Pirquet), intracutaneously (Mantoux), by rubbing into the skin (Moro), in the mucous membranes of the eye (Wolf-Eisner and Calmette), and in the mucous membranes of the nose, vagina, urethra, and rectum, as has been determined by various observers. The same phenomenon of sensitization is shown, either with or without toxic action, in both the local and focal reaction which occurs following the use of tuberculin. A small amount of tuberculin may produce evidence of sensitization; but larger amounts are required to produce toxic reaction.

Toxic reaction in tuberculin does not differ greatly, or at all, as far as I have been able to determine, from other toxic reactions. The general toxic syndrome is the same, apparently, no matter what protein is used. The action of the protein in the production of toxic symptoms is expressed upon the general nervous system, but particularly through the sympathetic nervous system. The localized symptoms of tuberculin sensitization which have been mentioned are not phenomena dependent upon central stimulation of the nervous system. They seem to be wholly a local inflammatory reaction affecting the fixed tissue cells, and differ entirely from the symptoms which have been described as belonging to general anaphylaxis.

The anaphylaxis syndrome comprises symptoms having their origin in the central nervous system, but differ from those which make up the usual general tuberculin reaction. Anaphylaxis is associated with general muscular weakness; changes in the blood, particularly lessened coagulability, circulatory changes; marked irritation of the musculature and secretory glands of the internal viscera; and changes on the part of the respiratory system—bronchial spasm being particularly marked. The small bronchioles are found to be in tetanic contraction. During the period of hypersensibility, the contractile force of the smooth muscles of the intestinal tract is markedly augmented; there is a fall in blood pressure; and a lowering of temperature. It is believed by Auer and Lewis[1] and Biedl and Kraus[2] that these spasms are not of central origin, but are peripheral, being produced by direct action upon the smooth muscles of the gut in a way similar to the action of adrenin, which acts upon the myoneural junction. They may be prevented, or decreased, by the use of atropin.

My studies of the antagonistic action of the parasympathetic and sympathetic divisions of the vegetative nervous systems, as they affect internal viscera, lead me to the observation that the syndrome of anaphylaxis is that of central stimulation plus an increased tonus in the parasympathetics. Whether this is a primary result of stimulation of parasympathetic centers; or peripheral parasympathetic stimulation, as suggested by many observers; or, whether it is a condition of paralysis of the sympathetics, is not yet determined. Evidence against it being due to central stimulation comes from experiments upon animals with cut vagi, where the syndrome still apears. The fact that the same anaphylactic symptoms do not occur in all individuals with equal readiness may be due to the differences in stability to their nervous systems.

The syndrome of toxemia, and that of anaphylaxis, as expressed on the part of the internal viscera through the vegetative nervous system, are antagonistic, as will be shown in the following table, in which I contrast the action of these two states:

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[1] Journal American Medical Association, vol. liii, p. 458, 1909; Journal of Experimental Medicine, vol. xii, 1910.
[2] Zeitschrift für Immunitätsforschung, Bd. vii, 1910.

SYNDROME OF TOXEMIA AND ANAPHYLAXIS CONTRASTED.

Toxemia	increases	blood pressure
Anaphylaxis	lowers	blood pressure
Toxemia	increases	temperature
Anaphylaxis	lowers	temperature
Toxemia	decreases	irritability of intestinal musculature
Anaphylaxis	increases	irritability of intestinal musculature
Toxemia	produces	relaxation of bronchial musculature
Anaphylaxis	produces	spasm of bronchial musculature
Anaphylaxis	causes	involuntary discharge of urine and feces
Toxemia	causes	contraction of sphincters

In dogs the parasympathetic hyperirritability is also further shown by vomiting.

Friedberger[3] and Friedberger and Mita[4] show that the effect of the anaphylactic state upon temperature varies according to the dosage and that it is possible to determine the minimal dose necessary for a temperature reaction. Quantities somewhat smaller than this fail to disturb heat equilibrium, and still smaller quantities produce fever. Friedberger has shown, experimentally, that depressions of temperature will follow in the normal animal upon quantities of antigen exceeding 0.5 c.c., while the temperature of the sensitized animal may be depressed by amounts as small as 0.0005 c.c. Both anaphylaxia and toxemia are produced by smaller amounts of protein in sensitized individuals than in those who are not sensitized because the specific proteolytic enzymes necessary for splitting up the molecule and liberating the toxic and sensitizing factors are already present. The above facts established by Friedberger, indicate that the whole picture of anaphylaxis is similar to that of a very marked toxemia, a condition which could result from a general overpowering of sympathetic cells. We can understand these reactions better by bearing in mind that both parasympathetics and sympathetics supply most internal viscera, and antagonize each other in their action. If any condition arises, whereby the action of one is reduced, or set aside, the other comes more strongly into evidence.[5] So, if we have a condition present which markedly stimulates the parasympathetics, this overcomes the sympathetics and gives an increased parasympathetic action; or, if we have a condition which paralyzes the sympathetics and sets aside their normal action, we again have an increased parasympathetic action. The difference in anaphylaxis and toxemia, as far as temperature is concerned, may be explained in this way. Fever is largely due to a stimulation of the cutaneous vasomotors, producing vascoconstriction and interfering with the elimination of heat.[6] The action of toxemia is to stimulate the vasomotor center. If the toxemia is so great, however, that it overstimulates the vasomotors then, instead of vasoconstriction, with rise of temperature, we have a cutaneous vasodilatation, with fall in temperature, perspiration, and collapse similar to that found in anaphylaxis.

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[3] Deutsche med. Woch., Nr. 11, 1911.
[4] Zeitschrift für Immunitätsforschung, Bd. x, 1911.

It will be noted from the description above that anaphylaxis is accompanied by a general weakness of skeletal muscles and increased irritability or stimulation of the visceral muscles. Since increased tonus in visceral musculature depends mostly upon increased parasympathetic tonus, we must assume either that anaphylaxis consists of a marked stimulation of parasympathetic centers (which experiments seem to contradict), or marked peripheral stimulation of the same; or a setting aside, due to overstimulation and paralysis of the sympathetic centers. Thus can we account for the bronchial spasm, vomiting, increased irritability of the muscles of the gastrointestinal tract, and voiding of feces and urine. While many observers have suggested that this action is not central, but peripheral, the syndrome is the same, whichever way it acts, and it must result from the same thing,—either setting aside the sympathetic stimulation or increasing the vagus stimulation.

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[5] Eppinger and Hess: Die Vagotonie. Sammlung Klinischer Abhandlungen, von Noorden, Heft 9 u. 10, 1910.

[6] Pottenger: The Syndrome of Toxemia—An Expression of General Nervous Discharge Through the Sympathetic System, Journal American Medical Association, January 8, 1916, vol. lxvi; and, Fever, a Part of the Syndrome of Toxemia: Vasoconstriction of the Superficial Vessels an Important Factor in its Production, New York Medical Journal, August 26, 1916.

In the employment of tuberculin I have never observed a general anaphylaxis. The local evidences of reaction to the sensitizing molecule, however, are frequently observed. *In explanation of the fact that general anaphylactic reaction does not occur commonly, the same as a toxic reaction when a large dose of tuberculin is given, we can only speculate. I am under the impression that it is prevented in some manner by the fact that the patient has been made tolerant of the sensitizing molecule by the existing infection. He builds up an immunity to the sensitizing or anaphylactic molecule, but not to the toxic molecule.* This suggestion is supported by the studies of Vaughan. Or, it might be, that a degree of tolerance is established against both the toxic and sensitizing molecules, but that the greater tolerance is for the sensitizing.

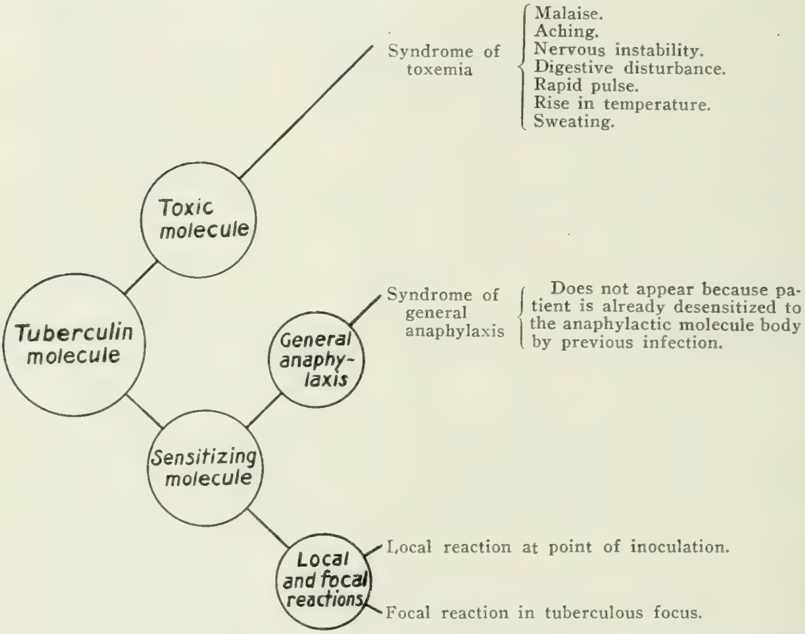
Syndrome of toxemia
Malaise.
Aching.
Nervous instability.
Digestive disturbance.
Rapid pulse.
Rise in temperature.
Sweating.
Toxic molecule
Tuberculin molecule
Syndrome of general anaphylaxis
Does not appear because patient is already desensitized to the anaphylactic molecule body by previous infection.
General anaphylaxis
Sensitizing molecule
Local and focal reactions
Local reaction at point of inoculation.
Focal reaction in tuberculous focus.

Fig. 131.—Schematic illustration of the phenomena associated with the tuberculin reaction. Tuberculin plus proteolytic enzymes sets free toxic and sensitizing molecules. The toxic molecule acts upon central nerve cells; and, particularly through the sympathetics, produces the syndrome of toxemia. The sensitizing molecule is either subject to further change resulting in (a) a general anaphylaxis molecule, and (b) a molecule which causes local and focal reactions; or, the sensitizing molecule itself produces these different phenomena according to the point of stimulation, whether it be on the parasympathetic system or the local and focal cells.

My conception of the action of the tuberculin molecule is shown schematically in Fig. 131.

Clinical Hypersensitiveness to Tuberculin.—I have seen a state of hypersensibility arise during tuberculin therapy on several different occasions; in fact, this seems a very troublesome condition in the experience of some men who employ tuberculin. The exact explanation of this seems in doubt, but I believe we can understand it best by taking it as being a condition of rapid reaction. Specific proteolytic enzymes are present in large numbers, and the tuberculin introduced is rapidly split up, and its component molecules set free to produce their respective effects. The intensity of action is based on the rapidity with which the toxic and anaphylactic molecules are set free to act. This explanation is in harmony with the writer's observation that such conditions may best be overcome by changing the preparation of tuberculin employed in treating the patient.

Such hypersensibility is not accompanied by the symptoms of anaphylaxis, which are noticed in animals, nor is it accompanied by the symptoms which I have seen following the use of horse serum in human beings, but it manifests itself as what appears to be a toxic reaction to a minimal dose, and usually, marked local redness at the site of injection. Patients even reach a state in which they are intolerant of the smallest dose. A dose much smaller than they have been accustomed to take prior to the development of the hypersensitive condition, produces the same toxic symptoms, and the same local evidences of marked sensitization at the point of injection as follow, ordinarily, upon a large dose of tuberculin. It is possible that a patient, while in this hypersensitive state, might be seriously harmed by the administration of large doses because of splitting the molecule in its component parts so quickly and permitting them to produce their respective toxic and anaphylactic symptoms. One can readily conceive of a large amount of protein being quickly split up and acting promptly upon the nervous system and producing disastrous results although in an extensive use of it over a period of more than twenty years I have never seen such occur.

Why Does the Tuberculous Patient Fail to Cure Himself With His Own Tuberculin?—It is impossible to give a satisfactory answer to this question. Many infectious bacteria produce conditions within the body which result in their own destruction, and leave the body with a grade of resistance which makes future infection impossible. This is particularly true in such acute infections as measles, whooping cough, scarlet fever and smallpox. Tuberculosis, however, is a different disease. It is a chronic infection. It is an infection where the microorganism is compelled to surround itself by conditions which make it secure; consequently, in the building up of the tubercle, and in the peculiar pathology which surrounds it, we probably have the reason why it is so difficult of cure. If tuberculosis is active, bacilli are multiplying, toxins (bacillary substances) are escaping into adjacent tissue, injuring the local cells and preparing the soil for metastases when bacilli make their escape. Under these conditions free circulation of body fluids does not exist in and near the focus of infection; and, as Wassermann and Bruck have suggested, the sessile receptors of the cells in the necrotic areas are probably fully satisfied; consequently, we may assume that there is not that close association of the substances which result in the focal reactions that are desired. In processes of little activity, bacilli are multiplying slowly, if at all, and are liberating few toxins (bacillary substances); and, inasmuch as these are essential to focal stimulation, and inasmuch as this is necessary to bring about a cure, the process stops short of healing. In those types of tuberculosis, where the process is quiescent, necrosis is not taking place; collateral inflammation exists only to a slight degree, if at all; and toxins (bacillary substances) are not elaborated, or fail to be elaborated in sufficient quantities to produce the focal stimulation that is necessary to cure, so the process stops short of healing.

Why the Administration of Tuberculin Aids Where the Patient Fails to Cure Himself.—The discussion of this question is closely bound to the preceding one; and, from the hypotheses discussed in this connection, we can offer a partial explanation of why tuberculin is of value when the patient fails to cure himself. It can readily be seen why tuberculin should be of value in those cases where the process itself ceases to produce tubercle toxins (bacillary substances), and discharge them into the circulatory fluids. The bacillary products, under such circumstances, when injected parenterally, at once puts the process again in operation which results in focal stimulation and healing. In those cases where considerable activity is present and the focus is surrounded by a collateral exudative inflammation, which causes a stagnation of lymph, it might be more difficult to see how the injections of tuberculin might be of value; although, even in these cases, its action is sufficiently established by clinical experience, to warrant its use.

Tuberculosis is a chronic infection and even in the active cases we find tubercles in all stages of development. We find every variety of pathological process which attends the disease. While some areas are the seat of markedly active lesions and so surrounded by exudative inflammation as to preclude or, at least seriously hinder the attainment of a focal reaction, others are going through the process of healing, and are surrounded by little or no exudation; and still others represent new tubercles in the process of formation. These latter, being more simple pathological processes are within easy access of the blood stream and may readily be influenced by a focal reaction. In being freed from those pathological processes which are least serious, the body is relieved of their harmful influences and thus enabled to more advantageously oppose the serious lesions. Every little area of infection that is removed in tuberculosis, helps the organism in overcoming the disease, to the extent that it affords relief from unnecessary drain and depression of the vital forces.

It is sometimes stated that tuberculin is particularly contraindicated in cases where active tubercle toxins are already present in sufficient quantities to produce clinical symptoms of toxemia. This argument seems valid; at the same time, my clinical experience opposes the argument. Personally, I have treated many cases suffering from active tuberculosis with tuberculin and have been convinced that its action has been beneficial. Such patients are not the ideal ones for tuberculin therapy; in fact, they are not ideal for any therapy. What I believe the tuberculin does in these cases is to hasten the destructive process and allow the necrosis and caseation to take place sooner, and thus free the organism of a prolonged toxemia. The focal reaction undoubtedly hastens the separation of necrotic tissue as Koch originally believed. Such a use of tuberculin requires the greatest judgment and caution; for, like a two-edged sword, it may cut both ways. It has seemed to me in many cases, even cases of acute caseous pneumonia, that I have been able to benefit the patient in this way. Long drawn out toxemia is prevented by producing more rapid destruction and elimination of necrotic material. This would be seized upon by some of the opponents of tuberculin as evidence of harm, and would be held up as being a measure too uncertain and too poorly controlled to be employed. Personally, I would not recommend tuberculin to be used in cases of active tuberculosis, except by those who have had long experience in its use. These cases, as a rule, are very serious and many of them are hopeless unless something can be done. Personally, I use tuberculin in such cases for the same reason that the surgeon uses his knife in advanced cancer, realizing that the chances are against the patient, but that, if successful, we may be able to separate him from a decaying mass, and rid him of a severe toxemia, thus affording him help by prolonging his life, and making him more comfortable. I especially wish, however, to condemn the practice of men, with little or no experience, treating any advanced active cases of tuberculosis with tuberculin. There are too many other things that can be used to advantage to feel the necessity of using a remedy like this, which is as pregnant with harm as it is with good. I would, however, at the same time urge those who have had wide experience to employ it in this class of cases.

The theory of Wassermann and Bruck throws some light upon the action of tuberculin in the presence of advanced caseous tuberculous processes. They propose that, when areas of necrosis occur in tuberculosis, the receptor apparatus of the cells in the necrotic area is already saturated, consequently, further reaction in these cells is avoided. This theory seems plausible and offers an explanation for the fact which must be evident to any observer that if bacillary substances produce a focal reaction when present in large amounts, there would be no time during the advanced active lesion when a severe focal reaction would not be present because bacillary substances must be gaining access to the blood stream in large amounts during this time. Such a condition could not exist without a rapid destruction of tissue and the death of the patient. I have frequently observed in tuberculosis of the larynx, where an advanced active lesion is present, and the patient is suffering from marked toxemia as indicated by the presence of a high fever and other symptoms of the toxic state, that no focal reaction is present. Upon the administration of tuberculin, I have been able to produce this focal reaction. It would seem probable that one explanation of this is that the artificial tuberculin might differ sufficiently from the natural tuberculin derived from the focus of infection to excite the formation of receptors which differ somewhat from those stimulated by the infection itself. Further light may be thrown upon this phase of our subject by recalling our previous discussion of the behavior of tuberculin or bacillary products within the organism. It will be recalled that tuberculin does not react as such. It is split up by the proteolytic enzymes which are present, into toxic and sensitizing molecules. As previously mentioned, the patient who is suffering from tuberculosis, is sensitive to the toxic molecule, but immunized against the sensitizing (anaphylactic) molecule. This is in accordance with Vaughan's experimental work and is confirmed by clinical facts; the patient develops the syndrome of general toxemia, but not that of general anaphylaxis. Therefore we propose that the degree of toxemia, which is in a sense a tangible expression of the action of the toxic molecules, liberated, is in no sense an expression of the degree of action produced by the sensitizing molecules, we may have a general toxic reaction with little or no sensitizing (focal) reaction. Needless to say, tubercle vaccines must be given with great caution and in amounts short of producing more than the slightest focal reaction in order to avoid harm resulting.

Choice of Patients for Tuberculin Treatment.—From the severity of the pathological lesions which are found in advanced tuberculosis it is impossible to secure a healing of a large percentage of this class, no matter what remedy or combination of remedies is employed. This applies no more to tuberculin than it does to fresh air, good food, or any other measure that would be used. The reason for this is that the lesion is larger and the fighting forces of the patient are less than they are early before the disease has existed for a long time and produced severe mechanical and chemical changes in the body. Patients free from toxemia, usually spoken of as ''fever free patients,'' are the best for tuberculin treatment, because the pathological processes are more easily influenced and because such patients permit of a more careful control of the effects of tuberculin. Patients with toxemia, however, may often be greatly improved by the cautious administration of this remedy. It seems to me that some increased tolerance to toxins is undoubtedly established through its use, yet this is not susceptible of proof. As previously mentioned, tuberculin is of value and aids greatly in the cure of these advanced cases, even though they may be suffering from a toxemia sufficient to produce temperature.

Indications and Contraindications for Tuberculin Treatment.—In writings on tuberculin, many indications and contraindications for its use are given; but, if one will analyze them carefully, they amount to about this: all patients who are favorable for cure are favorable for tuberculin treatment, and all patients who have serious complications which might reduce their chances of cure, are unfavorable for tuberculin treatment. This is true, but it is as true of other therapeutic measures as it is of tuberculin. From my conception of tuberculin and its action, I can conceive of few conditions where tuberculosis is present that tuberculin may not be used to advantage, if any other therapeutic measure may be used advantageously. I can understand how tuberculin, if used in sufficient dosage to produce marked focal reaction might be harmful in meningeal tuberculosis. I can also understand how, if used injudiciously, it might be generally harmful in cases of advanced active tuberculosis; but, if the remedy is used with judgment and if it is suited to the particular pathological condition present, I can see no contraindication for its use in any ordinary tuberculous complication that is found.

When Withhold Tuberculin During Treatment.—There are times in the treatment of every case when it is best to withhold the remedy. It is probably best not to administer tuberculin during acute complications, such as influenza and pneumonia. It should be withheld in the presence of hemorrhage.

Most contraindications set down, however, are more imaginary than real. The indications are,—a tuberculous process which it is desirable to aid in healing. For all those, however, who have had little experience in the administration of the remedy, I would limit its use to early tuberculosis, or to chronic inactive tuberculosis. It is far easier, and much less hazardous to the patient, to confine one's efforts to those who are not suffering from toxemia, until one becomes conversant with the use of this remedy.

The Preparations of Tuberculin Commonly Used.—Numerous preparations of tuberculin have been produced and special claims have been made for each one by its originator. All preparations which are made from the tubercle bacillus must be considered as antigens because they have the property of producing specific defense against themselves when they are injected parenterally into either the human or animal body. This is a universally recognized law in immunity. The fact is clear then, that the tuberculin which contains the various products into which the tubercle bacillus can be separated in amounts which closest approach the quantities found in bacilli in natural infections, should have the greatest value in creating a specific defense against the tubercle bacillus itself. Much[7] has described the various products which may be derived from the tubercle bacillus as "partial antigens," and has shown that by combining the greatest number of "partial antigens" in varying proportions to suit the individual case, he has been able to produce a higher degree of immunity than where he has employed fewer partial antigens in his experimental therapy. This has been confirmed by some observers and refuted by others, but it seems to be theoretically plausible.

Numerous different substances may be derived from the tubercle bacillus, according to its method of treatment; thus, there may be both a soluble and insoluble protein derived from it by dissolving it in water, or by treating it mechanically, by grinding and then dissolving it in water; also by treating it with alcohol and acids. So may various fatty substances be derived according to different ways of treating the bacilli.

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[7] Handbuch der Tuberkulose, Bd. i, Brauer, Schroeder und Blumenfeld: Johann Ambrosius Barth, Leipsic, 1914.

Each of these substances has definite specific properties and the treatment of the patient by the greatest number of them seems to me to be the most rational. Inasmuch as we are not able to build up, synthetically, a preparation which contains all of the products of the tubercle bacillus in the proper proportion, the best that we can do is to treat the patient with several different substances. This, Much has done, and reports encouraging results.

Von Ruck's Watery Extract is another preparation which contains many of the different products. These have greater immunizing properties than some of the preparations which are more limited in the number of substances which they contain.

We commonly divide preparations of tuberculin into those which are made from the extracellular toxins, such as Old Tuberculin (O. T.—Koch); Bouillon Filtrate (B. F.—Denys); Perlsucht Tuberculin (P. T. O.—Spengler); and those containing the intracellular toxins, such as Tuberculin R. (T. R.—Koch); Bacillen Emulsion (B. E.—Koch) ; Perlsucht Emulsion (P. E.—Spengler); and those which contain a combination of the extra- and intracellular toxins, such as Watery Extract (von Ruck) ; T. B. V. and P. V. (Spengler); and Tuberculin Beraneck.

The following is a description of some of the more common preparations taken from the author's paper in Hare's "Modern Treatment," and his book on Tuberculin.[8]

"*Old Tuberculin* (O. T.) Koch's original preparation, is the beef broth, containing 5 per cent of glycerin, slightly alkalinized, upon which human bacilli have grown for a period of from six to eight weeks, filtered and treated by boiling for an hour, and then concentrated over a water-bath to one-tenth its volume. It is a variable product, depending upon the virulence of the strain of bacilli, the development of the growth, and the medium upon which they grow. It contains 50 per cent of glycerine. The initial dose is 0.001 to 0.1 milligram. Maximum dose is 1 cubic centimeter=1000 milligrams.

"*Bouillon Filtrate* (B. F.) Denys, is the bouillon culture of human tubercle bacilli filtered through porcelain. It is neither concentrated nor has it been subjected to heat. Denys claims that it is more active than O. T., because the latter has been deprived of some of its active principles by heating. The initial dose is from 0.0001 to 0.01 milligram. Maximum dose 1 cubic centimeter=100 milligrams.

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[8] Tuberculin in Diagnosis and Treatment, C. V. Mosby Company, St. Louis, 1913.

"*Perlsucht Tuberculin* (P. T. O.), Spengler, is a filtered bouillon culture of bovine bacilli, concentrated in an incubator, at 37 degrees C. to one-half of its original volume. It is then restored to its original volume by the addition of glycerin. One cubic centimeter=100 milligrams of P. T. O. The initial dose is from 0.0001 to 0.01 milligram. Maximum dose 1 cubic centimeter=100 milligrams.

"*Tuberculin Beraneck* is a 20 per cent solution of equal parts of an unheated precipitate, caused by the action of 60 per cent alcohol upon a culture of tubercle bacilli grown upon a special unneutralized medium, containing glycerin, but no peptone, and an extract made by treating tubercle bacilli by a 1 per cent solution of orthophosphoric acid. The preparation contains both the intracellular and extracellular toxins. Those who have had experience in the employment of this product are convinced that it is less toxic than O. T. or T. R. The initial dose is 0.05 cubic centimeter of ^{A} to 0.05 cubic centimeter of $\frac{A}{32}$. Maximum dose 1 cubic centimeter strongest solution.

"*T. B. V. and P. V.*, Spengler, are preparations containing both the intracellular and extracellular toxins, the former being made from cultures of human bacilli and the latter from cultures of bovine bacilli. The bacilli from which these preparations are made are grown upon a special medium. The initial dose is 0.00000001 to 0.0000001 milligram. Same in febrile cases. Maximum dose .05 milligram.

"*Tuberculin R.*, Koch, is an emulsion made from living virulent human tubercle bacilli, which have been ground in a mortar and first extracted by water. It is standardized so that each cubic centimeter contains 10 milligrams of solid substance. The initial dose is 0.0001 to 0.0002 milligram of the solid substance; in febrile cases 0.00001 to 0.00002 milligram. Maximum dose 20 milligrams.

"*Watery Extract,* von Ruck, is made by extracting with water the pulverized bodies of bacilli, which have been previously washed free from culture-fluid with water, and then extracted with alcohol and ether for the purpose of removing fat. The initial dose is 0.001 to 0.01 milligram solid extract. Maximum dose 1 cubic centimeter original solution, 10 milligrams solid extract.

"*Bacillen Emulsion,* (B. E.), Koch, is a glycerin emulsion of living, unheated, virulent, human tubercle bacilli pulverized, containing 5 milligrams of solid extract to each cubic centimeter. The initial dose is 0.00001 to 0.0001 milligram solid substance. Maximum dose 5 milligrams.

"*Perlsucht Emulsion* (P. E.), Spengler, is a glycerin emulsion of crushed bodies of bovine bacilli made in the same manner as B. E. The initial dose is 0.00001 to 0.0001 milligram solid substance. Maximum dose 5 milligrams."

Bovine Tuberculin.—Following the studies of Theobald Smith and the announcement of Koch, which gave impetus to the differentiation between bovine and human tuberculosis, tuberculins were produced from bovine as well as human strains of the bacillus. There are many different theories advanced for the action of these preparations. Some, particularly C. Spengler, who was the first to use bovine tuberculin, considered that it was best to treat human infections with bovine tuberculin, and bovine infections with human tuberculin. Other men, on the other hand, have considered it best to treat bovine infections with bovine tuberculin and human infections with human tuberculins. The effort to carry out such therapy, however, has proved disappointing, because of the impossibility of determining clinically which infection is present. The theory which underlies the action of these preparations made from opposing strains of bacilli, is probably losing ground. When we know that artificial preparations of bacillary substances, no matter from what source the bacilli come, are not identical with the product elaborated in the patient's own tissues, we are led to believe that this is not an important factor in therapy. The writer has had a large experience in the use of certain bovine preparations, and has found them apparently less prone to produce severe reactions than preparations made from the human bacillus.

Choice of Preparation.—From what has been previously said, it is understood that any preparation made from the tubercle bacillus may be used to advantage in the treatment of tuberculosis. This does not imply, however, that all are equally favorable. Theoretically, at least, the one that contains the greatest number of partialantigens (Much)—thus the greatest variety of substances which may be derived from the tubercle bacillus is the best, as far as the production of immunity against the bacillus is concerned. According to my observations, however, there is far more in the method of administration than there is in the individual preparation. There are certain preparations that I prefer to others; at the same time, I believe that one's preference for these is largely due to the fact that he understands their action better, and is better able to suit the dosage to the pathological condition present. I think it is far better that the physician should master two or three preparations than attempt to give many.

Method of Diluting Tuberculin.—The dilution of tuberculin is simple, but must be made with aseptic precautions. Some people fail to use tuberculin because they fear that they do not understand how to dilute it. I think it is better, if one is only using it occasionally, or only treating a few cases, to have the pharmacist make the dilutions for him; but, if one is using it to any great extent, he should learn to make up his own dilutions. These should be made fresh. Concentrated tuberculin and the higher dilutions will maintain their strength much longer than the weaker ones. The weaker ones should be put up in small quantities and should be made fresh for therapy, at least every week or ten days. For the use of the subcutaneous or intradermal tuberculin test, I prefer to make dilutions fresh at each time of injection.

Any solution, either original or diluted, should be discarded if it becomes cloudy, indicating infection. The emulsions, such as B. E. and T. R., which contain suspended particles of the tubercle bacillus, will show a precipitate of the solid bacillary substance in the bottom of the bottle, which must not be confused with the cloudy appearance which follows when the product is infected.

Apparatus Necessary for Making Dilutions.—In order to make dilutions it is necessary to have a graduated pipette, or syringe, in which the divisions of measurement are standardized. It is preferable to have this graduated in the metric system. The caliber should be small because this reduces the percentage of error. It is very important to always use the same syringe, or the same pipette, in making dilutions, otherwise there might be a difference in the measurement, which would greatly alter a given dosage.

The method of making dilutions which is commonly employed in this country is to make each successive dilution one-tenth weaker than the preceding one. Neumann and Sahli, two of the most ardent supporters of tuberculin in Europe, have devised methods very different from this, in which they have provided for an accurate gradual increase in dosage, particularly for use among general practitioners. Needless to say, one who has had little experience in the use of tuberculin must, of necessity, follow some scheme laid down, and proceed with extreme caution. Caution, however, does not mean using minimal doses at long intervals.

It is very important in administering tuberculin to be sure that the dilutions are kept sterile. While it is possible that the tubercle protein in the bacillary product is somewhat changed by coming in contact with such chemical substances as tricresol and phenol, and that their action might be different if they were diluted by normal salt solution; yet, it is essential to use some such antiseptic in order to prevent the development of bacteria. I use as a diluent normal salt solution plus ½ of 1. per cent phenol. Denys uses normal salt solution, without any antiseptic. In using normal salt without the addition of an antiseptic there is danger that it might become contaminated with living bacteria and cause abscess formation. It is also necessary to use freshly distilled water, or to add the antiseptic to freshly distilled water if a stock solution is to be kept. Otherwise it may become contaminated, and even if the bacteria are destroyed by the tricresol or phenol, yet sufficient quantities of bacterial protein may be found in each dose to produce protein poisoning. This latter danger is not fanciful, but a real one. There is no doubt but that severe toxic reactions have now and then been caused in this manner.

The advantage of the physician making his own dilutions is that he can make them up more frequently, thus keeping them fresh. I rarely make more than one cubic centimeter of any dilution at a time. Thus, with many patients under treatment, a new dilution is made up every day or so.

TABLE I.

TABLE SHOWING METHOD OF DILUTING O. T. (KOCH), with value of 1 c.c. of dilution in both mg. and c.mm.

(Diluent: sterilized normal salt solution + .4 per cent phenol.)

	Solution No.	of which 1 c.c. contains	
		in milligrams	in cubic millimeters
1. c.c. original solution....................	0	1000.	1000.
.1 c.c. " " + .9 c.c. diluent	= I	100.	100.
.1 c.c. I " + .9 c.c. "	= II	10.	10.
.1 c.c. II " + .9 c.c. "	= III	1.	1.
.1 c.c. III " + .9 c.c. "	= IV	.1	.1
.1 c.c. IV " + .9 c.c. "	= V	.01	.01
.1 c.c. V " + .9 c.c. "	= VI	.001	.001

TABLE II.

TABLE SHOWING METHOD OF DILUTING A.T.O. (KOCH), P.T.O. (SPENGLER), AND B.F. (DENYS), with value of 1 c.c. of each dilution in both mg. and c.mm. The discrepancy between the columns in mg. and c.mm. is due to the fact that the mg. column is compared with Koch's old tuberculin, which is ten times stronger than A.T.O., P T.O., and B.F., in that it is boiled down to one-tenth its original volume.

(Diluent: normal salt solution + .4 per cent phenol. Denys prefers normal salt solution alone for B. F.)

	Solution No.	of which 1 c.c. contains	
		milligrams	cubic millimeters
1. c.c. original solution..................	= 0	100.	1000.
.1 c.c. 0 " + .9 c.c. diluent	= I	10.	100.
.1 c.c. I " + .9 c.c. "	= II	1.	10.
.1 c.c. II " + .9 c.c. "	= III	.1	1.
.1 c.c. III " + .9 c.c. "	= IV	.01	.1
.1 c.c. IV " + .9 c.c. "	= V	.001	.01
.1 c.c. V " + .9 c.c. "	= VI	.0001	.001

TABLE III.

Table Showing Method of Diluting T.R. (Koch) and Watery Extract (Von Ruck), with value of 1 c.c. of each dilution in milligrams of bacillary substance and cubic millimeters of original solution.
(Diluent: Normal salt solution + .4 per cent phenol. Koch preferred normal salt solution + 20 per cent glycerin for T.R.)

	Solution No.	of which 1 c.c. contains	
		bacillary substance in milligrams	original solution in cubic millimeters
1. c.c. original solution	=0	10.	1000.
.1 c.c. “ “ + .9 c.c. diluent	=I	1.	100.
.1 c.c. I “ + .9 c.c. “	=II	.1	10.
.1 c.c. II “ + .9 c.c. “	=III	.01	1.
.1 c.c. III “ + .9 c.c. “	=IV	.001	.1
.1 c.c. IV “ + .9 c.c. “	=V	.0001	.01
.1 c.c. V “ + .9 c.c. “	=VI	.00001	.001

TABLE IV.

Table Showing Method of Diluting B.E. (Koch) and P.E. (Spengler), with value of 1 c.c. of each dilution in milligrams of bacillary substance and cubic millimeters of original solution.
(Diluent: Normal salt solution + .4 per cent phenol.)

	Solution No.	of which 1 c.c. contains	
		bacillary substance in milligrams	original solution in cubic millimeters
1. c.c. original solution	=0	5.	1000.
.2 c.c. “ “ + .8 c.c. diluent	=I	1.	200.
.1 c.c. I “ + .9 c.c. “	=II	.1	20.
.1 c.c. II “ + .9 c.c. “	=III	.01	2.
.1 c.c. III “ + .9 c.c. “	=IV	.001	.2
.1 c.c. IV “ + .9 c.c. “	=V	.0001	.02
.1 c.c. V “ + .9 c.c. “	=VI	.00001	.002

Where preparations containing solid extracts are used it is essential to shake the bottle well before making the dilution. Extreme caution must be used in using preparations of this character, otherwise overdoses will now and then be administered.

The preceding tables will show the method of making dilutions of the more common preparations of tuberculin. It is suggested, particularly by Riviere and Morland, that in order to simplify the dosage and make the quantity of tuberculin employed more intelligible, we should discard the old idea of milligrams in which doses have been reckoned, and measure it in terms of the original solution of each preparation.

Method of Designating Dosage.—In my tables for making dilutions, I give both the old method in milligrams, which is erroneous for such preparations as Old Tuberculin and Bouillon Filtrate; and the new method in cubic centimeters, as suggested by these authors. It will be seen that it is necessary to give a different table for making dilutions for O. T. Koch, A. T. O., and B. F., because Koch's Old Tuberculin is concentrated to one-tenth its original amount. I consider O. T. alone in Table I, and take up the other extracellular products in Table II. Table III and IV take up the preparations containing intracellular toxins. I quote these tables from my monograph on tuberculin.[9]

I also wish to insert a table from page 163 from the same monograph, giving the dosage of each of the common preparations of tuberculin according to the suggestion of Riviere and Morland. This table gives the amount of the original substance in one cubic millimeter of each of six successive dilutions made from the original.

The method of designating the quantity of tuberculin used by a fraction or its decimal equivalent is confusing and operating against accurate knowledge of the size of the dose. One is lost in the multiplication of zeros, particularly in the small doses. I have been using, for the past ten years, a system which was given to me by C. Spengler of Davos. It is simple and yet it affords the accurate knowledge desired. It is a combination of fractions and letters. The letters represent the larger divisions of the milligram or gram, thus: m=millionth; t=thousandth; and h=hundredth. To represent the portion of each of these employed, fractions are added as here illustrated: 1/100 m mg. = .00000001; 2/100 m mg. = .00000002; 1/10 m mg. =

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[9] Tuberculin in Diagnosis and Treatment, C. V. Mosby Company, St. Louis, 1913, pp. 159 and 160.

TABLE V.

THE CUBIC MILLIMETER AS A UNIT OF VOLUME

Cubic Milli-meter c.mm.	Cubic Centi-meter c.c.	Contained in 1 c.c. of Dilution	Equivalent on older system of						
			Old Tuberculin. Bovine Old Tuberculin	T.O.A P.T.O. B.F.	T.R. Old Basis Koch	T.R. New Basis Ruppel	P.E. B.E.	T.B.K.	Watery Extract
1000.	1.	original	1000. mg.	100. mg.	10. mg.	2. mg.	5. mg.		10. mg.
100.	0.1	No. I	100. "	10. "	1. "	1/5 "	1/2 "	TB K_1 1.0	1. "
10.	0.01	No. II	10. "	1. "	1/10 "	1/50 "	1/20 "	TB K_2 1.0	1/10 "
1.	0.001	No. III	1. "	1/10 "	1/100 "	1/500 "	1/200 "	TB K_3 1.0	1/100 "
0.1	0.0001	No. IV	1/10 "	1/100 "	1/1000 "	1/5000 "	1/2000 "	TB K_4 1.0	1/1000 "
.01	0.00001	No. V	1/100 "	1/1000 "	1/10000 "	1/50000 "	1/20000 "	TB K_5 1.0	1/10000 "
.001	0.000001	No. VI	1/1000"	1/10000"	1/100000"	1/500000 "	1/200000 "	TB K_6 1.0	1/100000"

.0000001; 1 m mg. = .000001; 1/100 t mg. = .00001; 1/10 t mg. = .0001; 1 t mg. = .001; 1 h mg. = .01; 1/10 mg. = .1; 1 mg. = 1., etc. Doses are so designated in Chapter L.

If such a system as this could be adopted it would probably make for more accurate knowledge of dosage and do away with the common method of speaking of the dosage of tuberculin in terms of so many drops of such a dilution put up by biological laboratories.

It is extremely important that the physicians employing tuberculin should know how much of the preparation they are using. One can have no idea of the action of this remedy if he bears in mind that he is only giving so many drops of a certain dilution. He should know what this means—the quantity of the substance of the bacillus, or the amount of the original solution that this dose contains.

Method of Administering Tuberculin.—Tuberculin is usually administered by subcutaneous or deep muscular injections. It has been used intravenously, and by the mouth. It seems to me that our modern studies in protein sensitization show us definitely that the internal administration of tuberculin by the mouth must be uncertain and of limited or doubtful value. In order that proteins may produce their action they must be introduced parenterally. Protein that passes through the intestinal tract is acted upon by the enzymes found in the stomach and intestine and destroyed before being absorbed. The protein which enters the circulation from the intestinal tract, without being so acted upon, does so only accidentally. The protein, however, which is introduced into the tissues, or into the blood stream does not come in contact with the digestive ferments in the gastrointestinal canal, that they may destroy it; but it stimulates the body cells and causes them to produce special proteolytic ferments for its destruction. The elaboration of these specific proteolytic ferments results in the special specific defense known as immunity.

Some workers have claimed advantage for the intravenous injection of tuberculin, but most clinicians are not favorable to it. In most cases of tuberculosis which we are treating by tuberculin, we desire slow action. This is obtained by injecting the tuberculin subcutaneously or intramuscularly. The protein finds itself thrown into the tissues and comes at once in contact with the local cells. The specific ferments at once begin their action in the breaking up of the protein molecule, and rendering it harmless, preparatory to its excretion from the body. Injected into the body tissues in concentrated form, its toxic action is less than would be the case if it were thrown into the blood stream and scattered generally throughout the tissues of the body. Aside from this, the ease and safety of subcutaneous and muscular injections must be considered, as compared with the introduction of foreign substances directly into the blood stream. While today, with our aseptic technic, there is little danger in intravenous therapy, at the same time, for general use, the subcutaneous is preferable, where it can be used with equal efficiency.

Site of Injection.—Tuberculin may be administered hypodermically in any of the subcutaneous or muscular tissues of the body. For obvious reasons, however, there are certain sites that are more accessible and more desirable than others. A great deal of tuberculin is administered in the interscapular and lumbar regions and in the tissues of the flank. My preference is to administer it in the forearm. It is much more convenient and much easier to observe its local action when injected into the forearm than in any other portion of the body. The skin is not so thick and it is more accessible. The local reaction should always be observed when tuberculin is administered. While we cannot definitely guide our dosage by the local reaction, yet we can, to a certain extent, infer at times, something of the degree of sensitization of the cells by observing the reaction which takes place when the tuberculin is administered.

I have always considered it unwise to administer the successive dose of tuberculin until the active inflammatory reaction following the preceding dose has disappeared. It does not always seem necessary to wait until the nodule which follows the administration of an emulsion has entirely disappeared, although it is best to wait until the acute inflammatory signs have passed away. At this time I consider that practically all of the tubercle substance has been acted upon by the specific enzymes and, consequently the injection of the next dose is not apt to be followed by a reaction.

Time of Day of Injection.—Doses may be given at any time of the day,—whenever it is most convenient for the physician and patient. There are some advantages in giving it the last thing before going to bed. This plan, however, can be carried out only in an institution. The patient's being quiet for several hours after its administration may, under certain circumstances, avoid reactions; although it may be more difficult to determine the point of tolerance by this method than where it is given earlier in the day. If it is administered in the early morning hours, signs of reaction, should they occur, will usually be noted in the early afternoon, or evening. This gives a longer opportunity for studying the effect of the dose before the patient retires. Where it is administered in the early morning, or during the waking hours of the patient, it is best to enjoin a restriction of exercise for the day following the dose, after large dosage has been attained. In dispensary and office practice, however, it will be necessary to give the dose during the hours that are most convenient, and I have found that it makes little or no difference. A little more care in observing, and a little more care on the part of the patient is all that is necessary to make the administration safe and successful.

Methods of Dosage.—It is essential for one administering tuberculin to have in his mind some definite scheme for administering the remedy. While tuberculin can be given haphazardly, the same as any pharmaceutical remedy, or any physical measure, such as open air, baths, food, etc., yet, if one desires to obtain the best results, he must follow certain intelligent principles in its application. Tuberculin can be used routinely, but not to best advantage. I rarely give it to two patients in exactly the same manner, although I follow a definite idea as to interval and size of dosage in patients of a certain class. My dosage and interval depends upon the amount of reaction that I think the patient will tolerate to best advantage. The first thing I bear in mind is the pathology present, whether the disease is active or quiescent, whether it is extensive or limited, whether it involves delicate tissues such as those of the eye, where only slight reactions are permissible; or such as those in the lung or larynx, where a more marked reaction may produce no harm; and, on the other hand, may even prove advantageous.

The following charts are constructed from patients treated in the Pottenger Sanatorium for Diseases of the Lungs and Throat and graphically illustrate the degree of individualization employed in treating patients. It was not known at the time the patients were under treatment that the dosage was going to be charted, consequently, these groups represent actual methods which we carry out in practice.

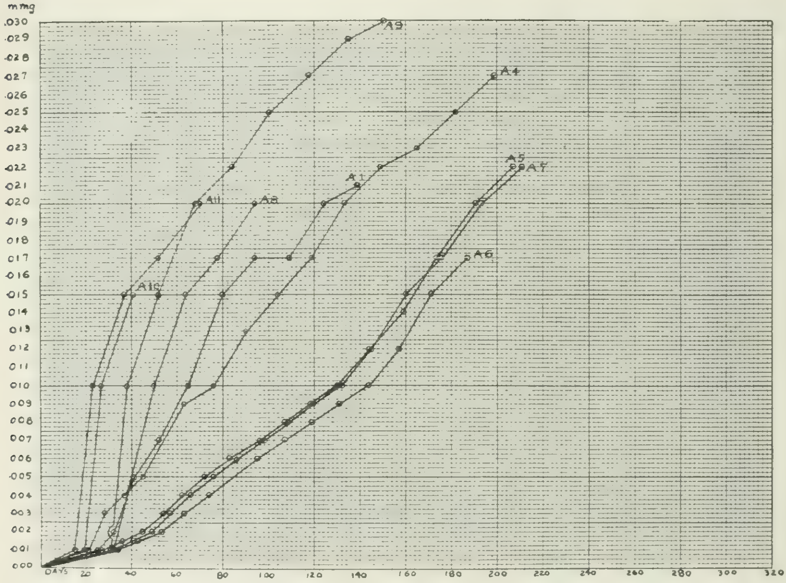

Fig. 132.—Group A. Cases illustrating method of giving tuberculin. The method of increasing the dose and lengthening the interval in treating early clinical tuberculosis. A high maximum is quickly obtained. Height of curve represents dosage; width represents days. P.V. and T.B.V. (Spengler) used.

Group A (Fig. 132) illustrates the method of using tuberculin in early clinical cases. It will be noted that a high maximum dosage was attained; and attained quickly. It will be noticed that the dosage was not increased as rapidly in cases A-5, A-6 and A-7 as in the other members of this group. This was due to the fact that A-5 was a patient with low vitality. A-6 had a more markedly active disease than the others, and

A-7 had a complication of diabetes; consequently, these three patients fall into a group almost by themselves.

Group B (Fig. 133) illustrates patients suffering from a moderately advanced tuberculosis. These have more extensive lesions than those in Group A, and lesions which are more active. In this group it will be seen that the curve does not rise as abruptly as in the preceding group, neither is as high a maximum obtained except in two instances, B-2 and B-3. These two cases represent the least active in Group B; while B-1, B-4 and B-5 are the most active. In these the maximum dose was not high.

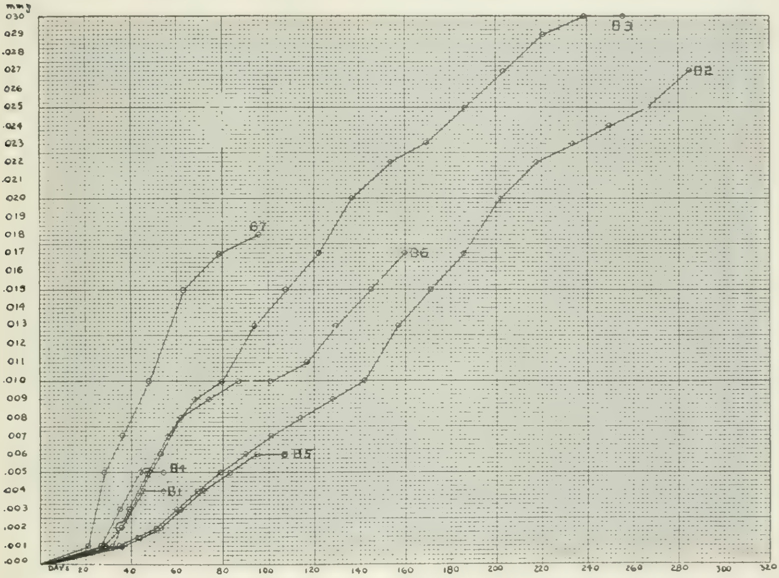

Fig. 133.—Group B. Cases illustrating the method of giving tuberculin in moderately advanced tuberculosis with little activity. The dosage is not increased so rapidly; neither is so high a maximum obtained as in Group A. Height of curve represents dosage; width represents days. P.V. and T.B.V. (Spengler) used.

Group C (Fig. 134) represents patients with moderately active disease, but not widespread. In this group of cases it did not seem best to provoke a marked focal reaction, consequently, they were not carried to a high maximum dose. The curves rise almost as abruptly, however, as those in Group B, but stop short of the maximum which was carried out in that group.

Group D (Fig. 135) represents patients who have a moderately active widespread trouble. In these cases the increase in dosage is still more gradual. The maximum dose attained is about the same as that in the more active cases in Group B and Group C. Only one patient, D-3, which was the least active in the group, was carried to a moderately high dosage. (See page 369.)

Group E (Fig. 136, page 370) represents patients suffering from widespread active tuberculosis. The degree of the activity can be fairly well judged by the character of the dosage. E-3, E-11, and E-5 were markedly active cases, and it was deemed best to increase the dosage very slowly so as to avoid a marked reaction. It will be noted that at the end of 80 to 140 days, we had only attained a dosage that was attained at the end of 40 or 80 days in Group A. With the exception of E-6 and E-17, there was a moderately high temperature present.

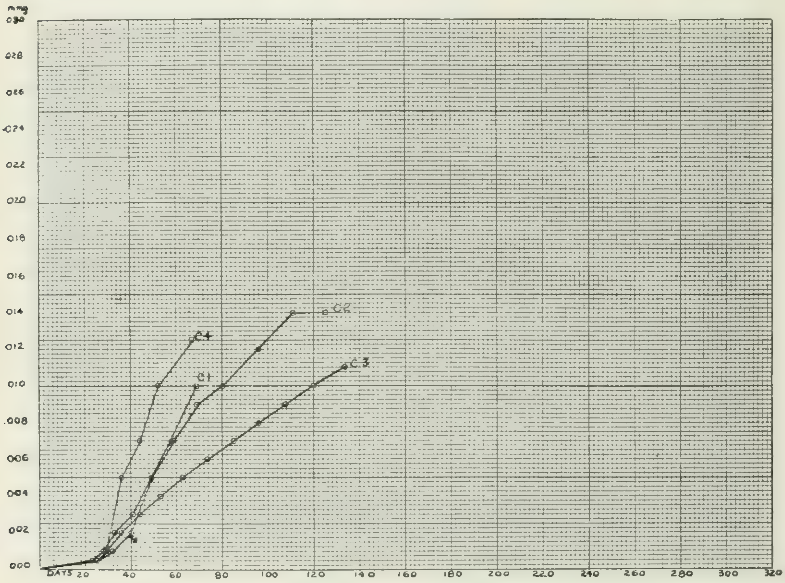

Fig. 134.—Group C. Cases illustrating the method of giving tuberculin in the treatment of patients suffering from moderately active tuberculosis in whom the disease is not widespread. The maximum dose is much smaller than in Group B, and is attained after a much longer time. Height of curve represents dosage; width represents days. P.V. and T.B.V. (Spengler) used.

Group F (Fig. 137) represents four cases suffering from advanced active tuberculosis, with moderately high fever. It will be seen that the rise of dosage is gradual and does not differ greatly from the dosage in Group E. The main difference consists in the maximum dosage that is maintained. F-5 and F-8 attained a higher dosage than F-2 and F-9. This was partly owing to the fact that these patients stood the dosage well. In the other cases we used only small doses so as to avoid any marked focal reaction. (See page 371.)

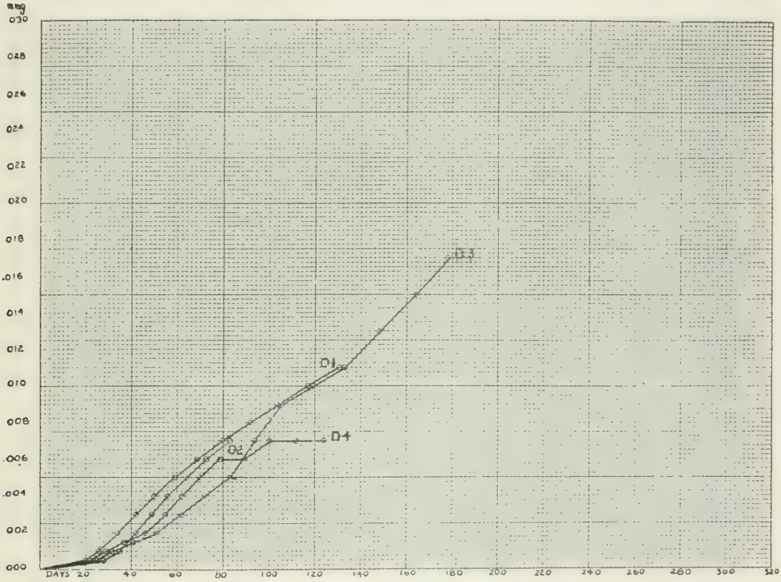

Fig. 135.—Group D. Cases illustrating the use of tuberculin in the treatment of moderately active widespread tuberculosis. The doses are very gradually increased; while the maximum dose is about the same as in the more active cases (Group C), though attained more slowly. Height of curve represents dosage; width represents days. P.V. and T.B.V. (Spengler) used.

It has long been my habit to be extremely cautious in the use of tuberculin. While it is my experience that the remedy may be suited to the patient, no matter what his condition, at the same time, it is necessary to avoid producing a focal reaction to such a degree as to do harm. When I arrive at the maximum dose that I think the patient will stand I either repeat it after a time, or change to another preparation of tuberculin,—starting at the lowest dose and going up until tolerance has been reached in the new preparation. This method of administering has given me excellent results.

The tables, pages 372, 373, and 374, from the author's monograph on Tuberculin (pages 164-166) will give schemata for dosage of the common preparations of tuberculin.

While it must be evident to anyone who understands the rudiments of therapy, that it is impossible to follow schemata like these, yet they are appended because they give a guide to those who are not familiar with tuberculin. The dosage of tuberculin, however, cannot be considered except in connection with the interval. There is much confusion regarding dosage. One of the most common conceptions of tuberculin is that large doses are harmful. A large dose depends on what doses have preceded it, and its action depends very much upon the interval that has existed between it and the preceding dose. The emphasis which Wright laid upon small doses has apparently reconciled the profession to a certain extent to the use of tuberculin. Their opposition was based largely upon fear of reac-

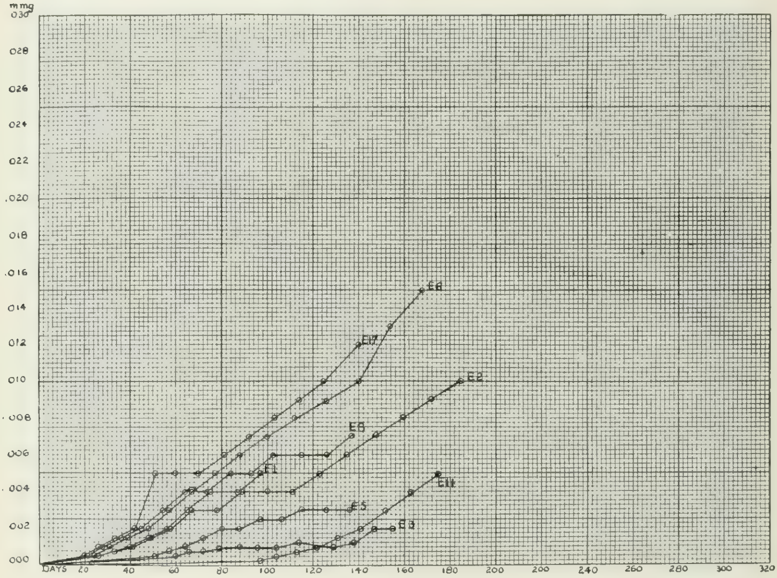

Fig. 136.—Group E. Cases illustrating the use of tuberculin in those suffering from widespread active tuberculosis. A low maximum dosage is attained; and this only after a long period of time. Height of curve represents dosage; width represents days. P.V. and T.B.V. (Spengler) used.

tions; and these are largely associated in their minds with large doses. This, however, is a wrong conception. The proper dose of tuberculin is the one which produces the desired effect when given at the proper interval following the preceding dose.

The action of a small dose of tuberculin lasts only a short time, while that of a large dose lasts for considerable time; consequently, the interval between doses must lengthen as the size of the dose increases. I have adopted a rapidly increasing method of dosage, with a gradual increase in interval and have found it very satisfactory. This method of dosage, as will be discussed under another heading, also avoids the production of a condition of increased sensibility, which sometimes proves very annoying to those who are administering the remedy.

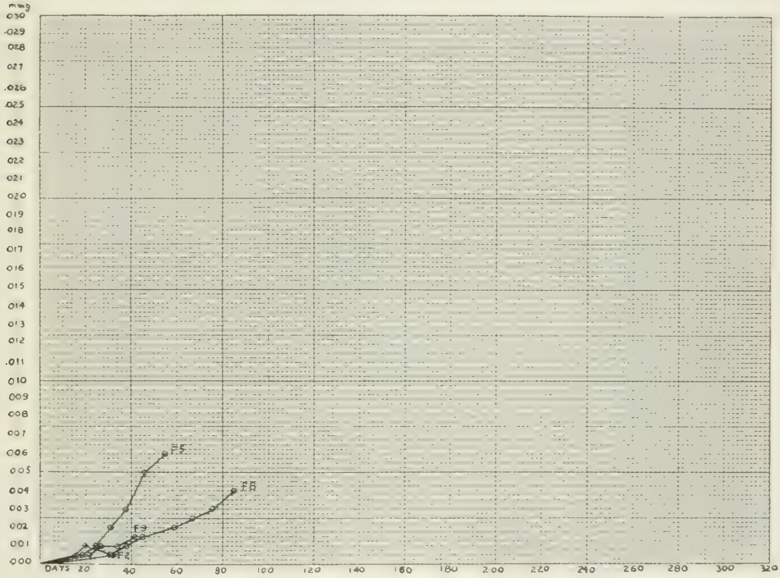

Fig. 137.—Group F. Cases illustrating the administration of tuberculin in advanced active tuberculosis with moderately high fever. The increase in dosage is very gradual. The dosage does not differ greatly from that in Group E; but a much smaller maximum is attained. Height of curve represents dosage; width represents days. P.V. and T.B.V. (Spengler) used.

There is a time immediately following each dose of tuberculin when a reaction would most probably follow if another dose were given. There seems to be a period of increased sensitiveness. This is later followed, however, by a period of

TABLE VI.

SCHEMA FOR O.T. AND A.T.O. (KOCH), P.T.O. (SPENGLER), B.F. (DENYS).

No. Days Showing Interval	Dosage Old Method	Dosage New Method
1	1/1,000 mg.	0.001 c.mm.
3	1/100 “	0.01 “
5	1/10 “	0.1 “
7	5/10 “	0.5 “
9	1. “	1. “
11	1 1/2 “	1.5 “
13	2. “	2. “
15	4. “	4. “
18	7. “	7. “
21	10. “	10. “
24	15. “	15. “
27	25. “	25. “
31	40. “	40. “
35	60. “	60. “
39	80. “	80. “
43	100. “	100. “
47	150. “	150. “
52	200. “	200. “
57	300. “	300. “
63	400. “	400. “
69	500. “	500. “
77	600. “	600. “
83	700. “	700. “
90	800. “	800. “
98	900. “	900. “
108	1000. “	1000. “

increased tolerance, or decreased sensitiveness. This period represents the time when the increased immunity response is not only evident, but at its highest point. This is also the time when whatever focal reaction was present has probably passed away. After this period of increased tolerance passes away, it is evident that a period of relative hypersensitiveness and increased liability to reaction again appears.

The length of the period of heightened immunity, likewise the time of return of hypersensitiveness, varies according to the patient's reactive powers and according to the size of the dose,—coming on quicker and passing off earlier after small doses than after large ones. It is during this period of increased tolerance that the next dose should be given. The increased danger of reaction, if a dose is given immediately following the preceding one, is probably partly due to the summation of action. The

TABLE VII.

Schema for T.R. (Koch) and Watery Extract (von Ruck).

No. Days Showing Interval	Dosage Old Method	Dosage New Method
1	1/10,000 mg.	0.01 c.mm.
3	1/1,000 “	0.1 “
5	5/1,000 “	0.5 “
7	1/100 “	1. “
9	2/100 “	2. “
11	5/100 “	5. “
13	8/100 “	8. “
16	1/10 “	10. “
19	1½/10 “	15. “
22	3/10 “	30. “
25	5/10 “	50. “
29	7/10 “	70. “
33	1. “	100. “
38	1 1/2 “	150. “
43	2. “	200. “
48	3. “	300. “
53	4. “	400. “
59	5. “	500. “
66	6. “	600. “
73	7. “	700. “
80	8. “	800. “
87	9. “	900. “
94	10. “	1000. “
104	12. “	1200. “
115	15. “	1500. “
130	18. “	1800. “
145	20. “	2000. “

two doses are larger than the specific proteolytic enzymes are able to destroy without setting free sufficient amounts of the toxic substances to produce a toxic effect. If, however, the succeeding dose is not given until the first dose has been acted upon by the specific ferments, then it will be cared for without reaction resulting.

The increased immunity following each dose lasts only for a certain length of time, which depends, as previously mentioned, upon the size of the dose. Then, if another large dose is given after this period of increased tolerance has passed away, the dose will again be too large and may result in reaction, the same as though it were given too soon. Fig. 138, page 375, taken from my monograph on tuberculin, shows schematically my conception of what occurs after a dose of tuberculin. When a dose is given it will be seen that the same general phenomena

TABLE VIII.

Schema for B.E. (Koch) and P.E. (Spengler).

No. Days Showing Interval	Dosage Old Method		Dosage New Method	
1	1/10,000	mg.	0.02	c.mm.
3	1/1,000	“	0.2	“
5	2/1,000	“	0.4	“
7	3/1,000	“	0.6	“
9	5/1,000	“	1.	“
12	7/1,000	“	1.4	“
15	1/100	“	2.	“
18	1½/100	“	3.	“
21	2/100	“	4.	“
24	3/100	“	6.	“
27	5/100	“	10.	“
30	7/100	“	14.	“
34	1/10	“	20.	“
38	1½/10	“	30.	“
42	2/10	“	40.	“
46	3/10	“	60.	“
50	5/10	“	100.	“
55	7/10	“	140.	“
60	1.	“	200.	“
65	1 3/10	“	260.	“
70	1 5/10	“	300.	“
75	2.	“	400.	“
80	3.	“	600.	“
86	4.	“	800.	“
93	5.	“	1000.	“
101	6.	“	1200.	“
110	7.	“	1400.	“
120	8.	“	1600.	“
132	9.	“	1800.	“
145	10.	“	2000.	“

TABLE IX.

Schema for P.V. and T.B.V. (Spengler)

No. of Days—Showing Interval	Dosage in mgs. Bacillary Extract
1	1/100,000,000
3	1/10,000,000
6	1/1,000,000
10	1/100,000
15	1/10,000
21	1/1,000
31	1/100

occur, whether it be large or small, although the time and persistence of each phase is short or long, according to the size of dosage.

The period of depression during which time there is probably a reduction in antibodies,—the negative phase according to Wright,—follows each dose and is short or long in accordance with the size of the dose. This is followed by a rise in defensive powers, as indicated by the line marked *B*, also being short or long in duration according to the dosage. This period cf heightened response is followed by the decline *C*.

The depression *A* in the curve corresponds to the period of incubation in infectious diseases, and represents a time when specific antibodies are developing. The tuberculin reaction differs from the reaction curve in acute infections in that it is an inoculation in an individual who is already immunized and corresponds more particularly to the secondary reactions which we meet in vaccination against smallpox, as studied by von Pirquet and Shick.[10] There is in tuberculin reaction, a temporary decrease in both fixed and free receptors, because they are called

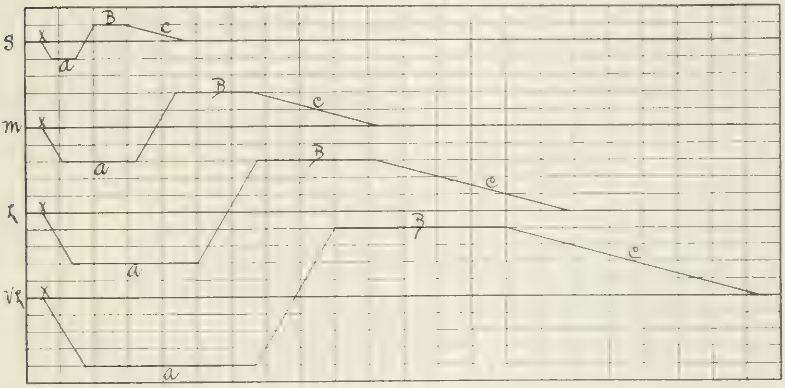

Fig. 138.—Illustrating schematically the phenomena which follow the administration of a dose of tuberculin, and showing when to give and when not to give the dose. *X* represents the time when the dose is given. The size of the dose is indicated as follows: *s*, small; *m*, medium; *l*, large; *vl*, very large. That part of the line marked (*a*) represents the period when the antibodies are reduced because of caring for the dose. It is marked by an increased hypersensitiveness and decreased tolerance of tuberculin. If another dose is given at this time, it is equal to increasing the dose *x* by the amount given, and if large enough, causes a reaction. *B* represents the time when the body has reacted in the production of an increased number of antibodies; therefore it is marked by decreased hypersensitiveness and an increased tolerance of tuberculin. During this time an increase in dosage is readily tolerated. *C* represents the time when the increased amount of antibodies resulting from the previous dose is gradually disappearing. This period is characterized by a gradual increase in hypersensibility and a gradually reduced tolerance to tuberculin. If a dose is given during this time, it is likely to cause a reaction, especially if the amount of tuberculin be increased. It will be noticed that the same phenomena follow doses regardless of size, but that the various phases are larger the larger the dose, showing that the interval between doses must increase with the size of the dose.

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[10] Die Serumkrankheit, Deuticke, Wien., 1906.

into use in order to satisfy the antigen. This is followed by an increase in their production, and, later, a gradual decline. The increases in dosage of tuberculin are followed by a lengthening of the period of increased defense; and, inasmuch as this is the time when the next dose should be given, it gives a wider limit for the period of safety than that which occurs during the smaller doses. This principle must be taken into account in spacing doses.

It is safe to give a small dose, with intervals of one or two days; and, if the dose be sufficiently small, the increase in amount may be very rapid; in fact, I begin all my preparations of tuberculin with doses so small that I know no reaction will occur. I rarely give more than .00000001 mg. of any preparation as my initial dose, but I increase this ten-fold at each injection, administering the doses every other day until I reach one the size that I know is sufficient to give a focal reaction. I then gradually increase my interval, although, in many instances I continue increasing the dosage tenfold, the same as before, until a dose considerably larger has been attained.

The period of maximum immunity, when there is a diminished danger of a reaction following the succeeding dose, is not a very long one. In small doses it is usually only one or two days; while in larger doses, it may be one or two weeks or more. A dose given short of this period of maximum immunity, or even after it has passed away, is more apt to be followed by a reaction, as previously discussed. This shows that the time of dosage cannot be shortened or lengthened, according to the whim of the one administering it. This is an important principle in using tuberculin, and I feel very sure that a failure to grasp the meaning of it is responsible for much of the inability to administer tuberculin without reactions.

This is well illustrated by the experimental evidence brought forth by Vaughan in his study of the type of temperature as produced by the toxic protein molecule. If a sufficiently large dose of toxin is administered a rise in temperature is produced which soon returns to normal. If repeated injections are given, on the other hand, a continuous fever curve is produced.

As I have said previously, in writing upon this subject,—"I do not believe that it is possible to administer tuberculin to the greatest advantage of the patient or the production of the greatest tox-immunity, and still control focal reactions, by giving it once a week, or twice a week, or every ten days, according to rule.''

With this conception of the phenomena which follow injections of tuberculin we have an explanation of the two principal methods of giving tuberculin,—one that of producing tox-immunity by gradually increasing the dosage until the patient tolerates a very large dose of tuberculin; the other by repeating at intervals of more or less frequency, the same dose of tuberculin. The former method, that of producing tox-immunity, is the one that I prefer. In my hands it has proved most satisfactory and given the best results. By this method I find that a patient can have the dosage increased within a short time so that he may tolerate a million or more times the first dose without producing a reaction. I cannot help thinking that the increased immunity to the tubercle protein in a given preparation furnishes, at least specific defensive products for some of the toxins produced in the focus of infection, for it does seem that tolerance to toxemia is increased and that toxemia is relieved. The other method,—that of giving the same doses at intervals, depends upon suiting the dosage to the

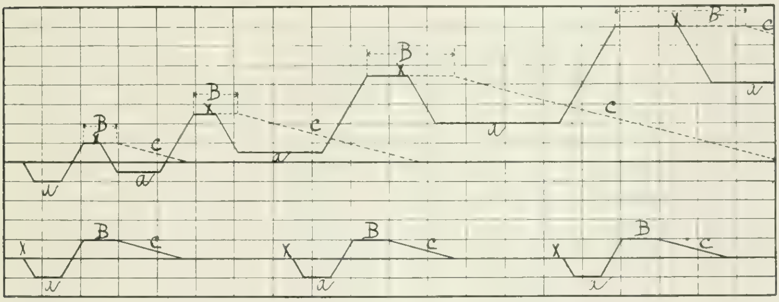

Fig. 139.—Schematic representation of the phenomena that occur: (1) in the repeated small doses, lower part of the figure; (2) in the production of tox-immunity, upper part of figure. It will be noticed that in the use of repeated small doses the phenomena occur after the dose is allowed to disappear entirely, and that each dose stands out as an individual injection. In the production of tox-immunity, however, each succeeding dose is given in the *B* portion of the line; and instead of the line gradually dropping back to the normal as it does in the individual dose, illustrated by the dotted line *C*, it takes a drop to *a*, and then rises above the line of the previous level, and thus builds up a decreased hypersensibility or an increased tox-immunity.

amount that the patient will tolerate. The dosage must be repeated sufficiently frequently not to produce a condition of hypersensibility and intolerance; for, as has been shown, according to the principles of anaphylaxis, if any foreign protein is injected into the body in small doses at infrequent intervals, after four or five doses, a condition of increased hypersensitiveness develops. That this does not occur more frequently in the administration of tuberculin in tuberculosis is probably due to the fact that while the tuberculin administered is not identical with the protein developed in the focus within the body, it is sufficiently near so that there is already a certain degree of desensitization or tolerance to it established. The introduction of tuberculin, then, even in the haphazard way that it is often employed, a way which would be disastrous if it were an entirely foreign form of protein, meets conditions which prevent increased sensitization occurring.

These two methods of giving tuberculin are illustrated in Fig. 139, page 377. It will be noted that each one is followed by the same phenomena, whether the method of tox-immunity is employed or the one of repeated small doses. In one, however, there is the gradual building up of immunity to the tubercle protein; and, in the other, there is probably only a focal stimulation and temporary increase in specific immunity.

Is Tuberculin a Safe Remedy for General Use?—This question is one that has been discussed a great deal. The general concensus of opinion is that tuberculin is not a remedy to put in the hands of physicians in general. This statement has a great deal in experience to substantiate it; at the same time I am accustomed to saying that any man who has enough intelligence to familiarize himself with disease so as to be able to practice medicine safely, should be able, if he will but give his time and attention to the matter, to use tuberculin with safety to the patient; and, at the same time, with beneficial results. If, on the other hand, he is not willing to study either his tuberculosis or his tuberculin, he should not attempt it. It is a remedy that can be given by rule, to a certain extent, but not most advantageously. It is essential to know the pathology of tuberculosis and the nature of the course of this complex disease, if one is going to administer any remedy which carries with it so much power for good when given rightly, and so much power for harm when given wrongly. There should be, however, physicians in every community, who are capable of administering tuberculin advantageously to their patients.

Tuberculosis today is a specialty. The best results are being produced by those who are giving the tuberculous patient close individual study. Men who are thus interested in this disease should familiarize themselves with the method of using tuberculin and employ it in their practice. The use of tuberculin is much like the employment of surgical procedures. It can be learned best by observation. The reason that we have so many enterprising, energetic, efficient surgeons is because there is keen competition among them and they take particular pains to go and see other good surgeons operate. There is a constant attendance of men eager to develop their surgical skill at the large surgical clinics of this country. There is no reason why men who are desirous of producing results in tuberculosis should not have the same chance. The Trudeau School for Tuberculosis, which has recently been established, should be a step toward meeting this demand and should be a great aid to those who are desirous of learning this special work. There should be other schools in other sections of the country which are capable of affording the same opportunity. It should be a part of such clinics to teach the administration of tuberculin.

The Importance of Pathological Knowledge and Careful Examination in Tuberculin Therapy.—From my previous discussion, the importance of understanding the pathology of the tuberculous process to be treated, can readily be gathered. The importance of this is based upon two facts;—the focal reaction following the dosage, and the varied character of the disease. This is an inflammatory reaction and takes place in and around the tuberculous focus. This reaction may be of any degree,—from a slight hyperemia to a severe congestion. It may be accompanied by slight or severe exudation. In some cases, such a reaction will do no harm; in others, it may prove very injurious. If one knows the pathology present he can more intelligently direct his tuberculin therapy. It proves advantageous to treat those patients in whom fibrosis predominates, with large doses and marked focal reactions. The same procedure would doubtless be harmful and might produce an irreparable injury, if directed toward the fibro-ulcerative type of the disease. The dosage must also vary according to the tissue involved. A large dose might be tolerated in the lung, when it would not be tolerated in an eye or a meningeal lesion. These conditions must all be considered in using tuberculin therapeutically. One must also necessarily be conversant with the clinical course of the disease. He must understand that tuberculosis is a disease which runs an uneven course in which, when activity is present, there will be a rise of temperature and other symptoms which make up the syndrome of toxemia, their severity depending upon the degree of activity present. These periods are often followed by others, during which the patient is free from toxic symptoms. These alternating periods of activity and quiescence go on, oftentimes, during many months before the disease assumes a permanent quiescent state. Without such knowledge it is impossible to properly interpret the effect of the tuberculin administered. One might think that natural pathological activity is due to the tuberculin; or he may fail to recognize a too severe focal reaction produced by the tuberculin and consider it as due to the natural course of the disease.

It is also necessary to bear in mind that these patients are subject to many other complications which produce the toxic syndrome. There are many acute infections, likewise complications, either tuberculous or non-tuberculous, which produce a transient or continuous toxemia. He must also understand the effect of the depressive emotional states in producing the same syndrome as that of toxemia, as discussed in Volume I, Chapter VIII.

In order to possess this knowledge not only is the study of pathology necessary, but an intimate association and acquaintance with the patient. This can be determined only by careful, complete examinations made sufficiently frequently to acquaint the examiner fully with the disease and the patient. Fortunately, the employment of tuberculin has brought into use the graphic temperature chart. This has been a great forward step in the study of tuberculosis. At a glance one may see the picture of the temperature curve extending over a period of months. This temperature curve should not be considered as an entity; but, as an index to the patient's toxemia, unless it is affected by the depressive emotional states, or other factors which cause an elevation of the curve. There is no other sign or symptom that can be compared with the temperature curve in giving one an idea of the progress of the case, as far as the presence or absence of toxemia is concerned, because different types of toxemia, as represented in the chart, are indicative of various pathological processes which produce toxemia. An appreciation of this can be obtained from Chapter XXX. Normal temperature, however, does not mean healed tuberculosis.

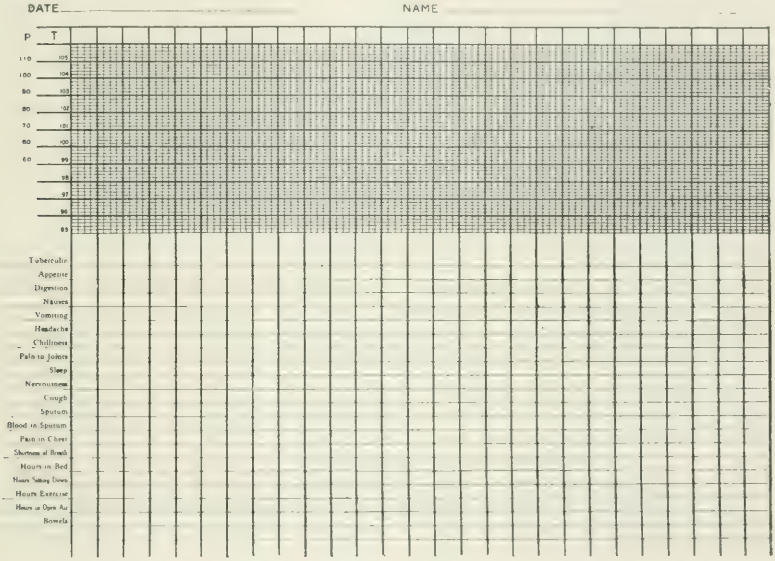

Fig. 140.—Illustrating a convenient graphic chart for the temperature and pulse with record of symptoms added. Used by Dr. George H. Evans of San Francisco. A month's chart is much better than one for a shorter period.

Not only is it desirable to keep a graphic temperature chart, but it is desirable to record on this chart other important data, such as the pulse rate, the sputum curve, the weight curve; and, in the case of intestinal tuberculosis, the number of stools per day. This gives a fairly accurate clinical history of the important points as the case progresses. Brown, of Saranac, has devised a general booklet to be used by patients who are receiving tuberculin treatment, in which he has arranged for the tabulation of the presence or absence of the common symptoms which are present in tuberculosis. This may be used advantageously to both physician and patient. It affords an excellent method of control of the patient. The same data has been added to the temperature curve by Evans, of San Francisco, as is shown in Fig. 140.

Physical Examination of the Patient.—Physical examination of the patient is another important part of tuberculin therapy and is more important than where tuberculin is not employed. This examination should be made sufficiently frequently to keep the attending physician acquainted with the pathological changes which are taking place in the part affected. In determining the frequency of examination, one should take into consideration the fact that pathological changes take place slowly. The examination is for the purpose of determining whether or not changes have occurred; whether areas have broken down; whether there are new processes of active inflammation; and whether still others have gone on toward healing. I have found it sufficient to examine my patients once a month; in fact, for those who have attained a state of arrestment, and in whom active symptoms have disappeared, an examination once in two months is sufficient, although I usually examine all every four or five weeks. At each examination a chart should be made. This gives one a record for comparison; and, while even at best it is more or less inaccurate, if carefully made, it will give one a fair working guide for the management of the patient.

The Length of Time Necessary for Tuberculin Treatment.—The question is usually asked, "How long is required for tuberculin treatment?", as though it were a definite course of treatment; or, as though it were a treatment of so many doses, or one which depended upon attaining a certain maximum dose. Our answer to this depends on both our conception of tuberculosis and the action of tuberculin. There has been a general tendency among clinicians to try to cure the disease faster than the pathological changes can take place. At best, it is a long drawn out period of treatment, and it is natural to desire to complete it as soon as possible; but it cannot be completed short of the time necessary to make the necessary pathological changes. The rapidity with which a lesion will heal depends upon its extent, its severity, and the reactive powers of the patient. One patient will make as good progress in six months as another one will make in nine months or a year; but, leaving out of account these unusual cases, an early case of tuberculosis must be watched and cared for, at least intermittently, over a period of from six months to a year. A satisfactory healing, however, will not take place except after a much longer time than this. A more extensive lesion and a more advanced process may require double, or even more than double this amount of time for a suitable result to take place. Many patients who fail to secure a satisfactory result in six months could do so in nine months, and many patients who fail in nine months might succeed in a year. Persistence is important; and as long as pathological changes are favorable, treatment should be continued.

It is sometimes best to interrupt the treatment of tuberculin. I often treat my patients until the physical signs in the chest are those of arrestment, the chest being practically free from moisture; or, in case cavities are present, until the moisture is confined to the cavities. Then I let the patient rest and live the ordinary hygienic life without tuberculin, over a period of from three to six months. I then resume tuberculin for three to six months. After this, I permit another long period of rest, after which I again administer the remedy for a short period of time.

It is quite noticeable, in my experience, that patients so treated are usually given the benefit of this extra therapy at a time when they are likely to begin to go down without it. The extra stimulation which is given them at this time seems to make healing more satisfactory. Very often, patients who have not put on weight during the first treatment, do so during the second or third periods in which they receive tuberculin. It is also very common to see the physical endurance and the nerve balance of the patient greatly improve during these later periods of tuberculin treatment.

This method was first suggested by Petrushky, and is spoken of as the "Etappen Methode." Patients who are treated by this method seem to retain a condition of health much more satisfactory than those who are treated for a single period, particularly if it is a short period. The great objection to this method is that patients cannot be relied upon to return for the second and third periods of treatment. They are willing to undergo treatment until they obtain a certain degree of health, but, if permitted to interrupt it at this time, there is a large proportion who cannot be relied upon to resume treatment when it is desirable. The result is that this method, while superior to the method of one long term of treatment, has in it the elements which make it impractical.

The Effects of Tuberculin Treatment.—What can be claimed for tuberculin treatment? This is a difficult question to answer, because no man who is capable of intelligently administering tuberculin would be satisfied to employ tuberculin alone. Tuberculosis is a many-sided disease. It is one in which we, unfortunately, do not have a specific upon which we may safely rely for bringing about a cure. If we wish to treat this disease intelligently, we must employ those measures, or enough measures which have a tonic stimulating effect upon the patient's cellular activity, so that the metabolic processes within the body will be carried on normally; keeping up the ordinary repair; relieving the harmful effects produced by toxemia; and having sufficient reserve energy left to overcome and heal the tuberculous infection. In some cases either open air, good food, rest, or psychotherapy may be sufficient to produce this effect in itself. In others we may have to combine them, or even add more. Tuberculin acts by stimulating the defensive powers of the cell. These defensive powers of the cell are greatest when the cellular activity is nearest normal; consequently, it would be foolish to use tuberculin and rely upon it alone. It should be reinforced by other measures which stimulate the reactivity of the body cells so as to give it an opportunity to act to greatest advantage.

The efficiency of tuberculin has been especially shown in the treatment of tuberculous laryngitis. This serious, and formerly hopeless complication of pulmonary tuberculosis, has now assumed the same status as pulmonary tuberculosis. If the laryngeal lesion is not too active, in a patient with favorable pulmonary involvement, his chances of healing are good. Even some cases which have a serious pulmonary lesion may obtain a healing of their laryngeal lesion. If, however, the laryngeal infection comes on as a terminal complication, and is associated with activity in the lung and a rapidly spreading disease in a patient whose body cells have lost their powers of reacting, then little hope can be offered by the use of tuberculin, or any other remedy, or group of remedies.

The effect of tuberculin, as studied in the larynx, has demonstrated to me, beyond question, the effect of the focal stimulation in the production of fibrosis.

I have had an opportunity of observing and treating several cases of tuberculosis of the tongue (see page 104), and here I have been able to observe carefully the effect of the tuberculin dosage. This, being an infection of muscular tissue, is extremely difficult to heal, although, as a rule, the process has been chronic in character. Following many of the doses of tuberculin, I have seen a hyperemia appear about the focus of infection. By keeping them up over a prolonged period of time, I have been able to secure healing in all instances where the pulmonary disease was not too active. In one case, which is under my treatment at the present time, I have kept up this focal stimulation during a period of more than two years, and am finally attaining a result. Two ulcerations were present at the beginning of treatment and the patient was suffering from an active pulmonary lesion which had gone through periods of marked activity with high fever. Regardless of this, one ulcer healed many months ago. The other has healed several times, only to open again; but now it seems to be definitely healed, and a scar, which is apparently firm, has taken the place of the former site of ulceration.

It is not necessary, however, to have these visible evidences of fibrosis following the use of tuberculin, to prove its efficacy. We see the same thing in our pulmonary cases. The amount of fibrosis and the rapidity of its formation may be determined by the amount of contraction in the lung, as evidenced by the shifting of the mediastinum. We often times see, during our administration of tuberculin, a rapid formation of scar tissue; a drying in the process, as determined by physical examination; increased harshness, indicative of an increasing amount of fibrosis; and a shifting of the mediastinum toward the side of involvement showing the contraction. I have seen as much contraction take place following a few months' treatment of tuberculosis with tuberculin as would occur, ordinarily during a prolonged period of observation without such therapy. It is not uncommon here in our institution to see these contractions and shiftings of the mediastinum and diaphragm take place month after month, the amount taking place between monthly examinations being sufficient to make them easily demonstrable upon palpation and percussion.

Not only do we have these evidences presented to us on observation and physical examination; but, by observing our patients and studying their after history, we see that definite healing is produced in a larger percentage of cases than is produced where tuberculin is not employed.

Statistics in tuberculosis are of little or no value because the ideas of observers differ so greatly and because individual methods are so much at variance. It is impossible to compare the work of any two men. One man will give a very different opinion of the amount of involvement present, from that of another man. The opinion as to when the patient is arrested also differs, depending largely upon the experience and ability of the examiner; consequently, it is impossible to obtain any comparative data upon which to base conclusions as to the value of tuberculin therapy. My own personal opinion of cases is very different now from what it was in the earlier years of my work and my results then and now are not comparable. The same objection may be made, although it holds to a lesser extent in some, to almost any other statistical investigation.

Theoretically, there is no doubt of the value of tuberculin as a therapeutic measure. Clinically, there is considerable doubt, if one considers the opinion of all observers, regardless of their right and ability to give such an opinion. If one, however, will take the same attitude toward tuberculin that he does toward surgery, or other therapeutic measures in medicine, he will then be forced to agree that tuberculin has value. All men do not obtain satisfactory results with tuberculin, neither do all men with any other therapeutic measure. If we take as our standard the best results that can be produced, then we must admit that tuberculin is a valuable measure in the therapeutics of tuberculosis.

CHAPTER XLI.

PSYCHOTHERAPY.

The Principles Underlying Psychotherapy.—Throughout history, medicine has been surrounded by mystery. There has been a childish faith in the power of the physician over disease which has not been warranted by his scientific knowledge. The chief rôle of the physician has hitherto been that of family counselor and friend. The physician of the old school, as immortalized by Ian MacLaren, was a man of heart, keenly interested in the lives and happiness of his patients, giving them advice upon non-medical matters as well as those which fell within his sphere. He was the man who inspired hope and gave courage to those who were ill and advised and helped all who were in need of good counsel. He knew little scientific medicine because there was little of it to be known. He had a smattering of anatomy and physiology, and was armed with many drugs in which he had unbounded faith. He was familiar with many observations of the masters which had been handed down from physician to physician, some of which were founded on truth and some on error. In spite of his lack of scientific training, he made for himself a firm place in the hearts and homes of his patients. He did not cure by his knowledge of medicine, but by his knowledge of human nature. He added to the remedies which he administered, the weight of common sense and the influence of cheerfulness and sympathy. He jealously guarded his position of influence in the family councils; and it was one that could not be displaced by cults and isms.

When scientific medicine began to make itself felt it opened up new fields of investigation in such rapid succession that the physician was obliged to change. He was compelled to adjust himself to new conditions. During the past quarter of a century so much of a truly scientific nature has been revealed that the entire subject of medicine has been rewritten. As a result of this, the tradition of the fathers has given way to the scientific facts of recent times. So great has been the demand made upon the intellectual powers of recent students of medicine that they have, for the time being, been almost wholly engaged in the study of disease. As a result of this they have sacrificed the study of the individual; and made it secondary to the study of the disease. Doctors are so busy endeavoring to make diagnoses and attempting to apply scientific facts, which are being continuously brought forth in the treatment of disease, that the accusation can be made, all too justly, that they are forgetting that the disease which they are studying exists in a human being. This condition is partly responsible for the lack of confidence which the physician has experienced during this period of transition. He is far more deserving of trust today than at any time in history because he is better equipped to cope with disease; yet he has sacrificed the principle of sympathy and human interest, which gave him so much power in times past, and as a result of this has temporarily lost the confidence of the public.

This mistake will right itself ere long. Members of the medical profession are already seeing that the human interest is essential to success and they are endeavoring to retrace their steps and again become the sympathetic helpful friend as well as the bearer of scientific truths. It is important to study disease. Physicians should be well equipped with the best knowledge on the subject of modern medicine. It is equally important, however, to study the patient and to be able to bring out the best that is in him as an individual.

The treatment of the patient as an individual lies within the province of psychotherapy. The treatment of all diseases, whether we recognize it, or not, has a psychic bearing. There is a psychological as well as a physiological basis.

Man gains his impressions from without by means of his senses. These are not all physical. Some of them are psychical. The psychical have no less bearing and no less influence upon the physiological activity of the body cells than the physical. This fact has not been sufficiently appreciated in the past but it is one that will be developed and amplified in the future. Man is a living, thinking, hoping being, as well as one who is given to eating, breathing, moving, and feeling. His life is made up of experiences. These experiences produce their effect on certain cells with which he was originally endowed. The impressions that are made upon these cells determine their development and future activity; in other words, a man's education is his inherited characteristics modified by his experiences. Cellular growth and physical development are produced by the sum total of the experiences through which the individual passes. He can have no thought that is not based on things which have previously come to him and made an impression upon his nerve cells. His hopes are based on the experience of others and the impression which these experiences have transferred to him. It is as much the province of the physician to recognize these factors, and to improve the method of thought and change the physiological working of the body cells through psychic influences as it is to change them through physical means. Attention to the individual will oftentimes relieve as much, or even more, suffering than attention given wholly to the diseased organ. Psychotherapy helps the patient to cure his own disease by improving the function of his own body cells through orderly psychic influences. The material side of medicine, on the other hand, attempts to treat disease as an entity, and find remedies which will destroy or remove the disease producing factor. The two combined are ideal. Each, alone, may produce satisfactory results in a large percentage of cases, but combined will prove to be far more efficacious.

The depressing influence of the emotions upon physiological activity has been well established by modern physiologists; and it is the duty of the physician to be as earnest in endeavoring to improve metabolic changes through psychic control as it is through physical. The diseases of metabolism are greatly improved by the patient living a properly regulated, hopeful, contented life. So can all chronic infections be relieved to a certain degree in the same way; in fact, there is no diseased condition that cannot be influenced by the proper psychic attitude of the patient. Psychotherapy creates about the patient an atmosphere of optimism and encouragement. It gives him hope for something better. It teaches him to look for and expect relief. It displaces depressive ideas and puts cheerful ones in their stead. Psychotherapy consists in helping the patient by positive teachings, to look forward to continuous improvement. It displaces negative harmful ideas.

Psychotherapy, to be of greatest value, must be adapted to the individual. The patient must be studied in the light of his past experiences and must be treated according to the degree of intelligence which he possesses. The higher the grade of intelligence, the more amenable he is to proper suggestion and the easier is it to lead him into the proper field of thought.

In order to understand the principles of psychotherapy, we must realize that every action of the body is under the control of the nervous system. We must conceive of these central cells being constantly bombarded by impulses coming from without. Many of these influences are normal and many of them abnormal. We may infer that the effect of these impulses depends considerably upon the degree of their intensity and their persistence. While the cell might come out uninjured by a short stimulation; yet, if kept up sufficiently long, we can conceive only of disturbed function resulting. Thus, injury to a peripheral nerve will produce pain. The continuous stimulation from the injured part increases the irritability of the cell which receives the impulse to an extent which is manifested by painful sensations.

The constant action of toxins upon the central nerve cells disturbs their equilibrium and brings them to a point where they functionate abnormally. We have all seen patients complain of pain, where the physician has told them that there was no cause for pain. It is necessary to realize that in conditions of this kind, the threshold of response of the nerve cells is probably lowered and the cell reacts to the sensation of pain in a condition which, if the cell were normal, would not be experienced as a sensation at all. Nerve cells should be shielded as much as possible from abnormal stimulation. If the stimulation is not kept up long enough to produce serious injury, their function may be restored and a normal condition be attained after the stimulation has been relieved. Even if the nerve cells cannot be wholly relieved, a partial relief may help restore such a degree of equilibrium as will be followed by a fairly normal functionating capacity.

The practical working out of the above facts is seen in so-called neurasthenics and psychasthenics. The nerve cells in these patients have been bombarded by harmful impressions for so long that they functionate abnormally, rather than normally. If these patients can be relieved of such abnormal stimulation, by being given a brighter outlook, by being shown that there is hope ahead; if they can be given freedom from the depressive emotional states; and, if this relief can be kept up sufficiently long, the threshold of response in the nerve cell will rise and many of the abnormal acts, to which the patient has been accustomed, will disappear. Pain, sleeplessness, discouragement, worry, fear, digestive disturbances, abnormal heart's action, and abnormal thought, may all be improved or removed in this way.

Psychotherapy is an integral part of medicine and belongs as much to it as the administration of drugs and the use of the surgeon's knife.

The mentally and physically perfect man does not exist. Such would be one whose every thought and every action is in perfect equilibrium. Everyone is warped in some particular. Our experiences do not always give us the normal impression because they are interpreted according to our own previous experiences. It is the part of the individual who would use suggestion or psychotherapeutic measures to analyze each patient as an individual and endeavor to give him a normal point of view; to change his wrong impressions and wrong methods of thinking; and, with a process of positive education, help his mind to normal thought. There is no doubt at all that many diseases could be averted by leading normal lives and having normal thoughts. This statement is illustrated by the individual who worries himself sick over some financial loss, or the loss of some friend, or some severe disappointment which comes into his life. There is likewise no doubt that many patients are greatly relieved when abnormal thoughts are removed and they are led into right ways of thinking. This is evident to all physicians; and to some it is more evident than to others.

When the patient is told that he has some severe illness, it is apt to produce depression unless the physician is careful to accompany his statement with hope. If the news carries with it mental depression the patient's appetite declines, his digestion weakens and his general metabolic processes are depressed.

This takes place according to the physiological law that all functions of the body are under nerve control, and nerve impulses are influenced alike by physical measures, chemical measures, and psychical conditions.

In this connection the experiments of Cannon, cited in Volume I, Chapter X, in which he recites the fact that he was able to observe the entire stoppage of peristalsis, for a period of an hour, produced in a cat by anger; and a further observation of normal movements during a similar experiment, in a cat that was contented and happy, are of the utmost importance.

This and other physiologic observations which show the nervous control of visceral activity through the sympathetic nervous system is the basis of the good results that are obtained in so-called functional diseases when treated by Christian Science, mental healing, and such kindred measures. The followers of these cults, however, in their ignorance of physiological laws, account for the beneficial results observed in ways either mystical or religious; when, in reality, they are produced in a perfectly orderly and normal manner through the action of nervous impulses upon the body cells.

Psychotherapy has an important place in the treatment of tuberculosis because of the nature of the disease. This is a chronic toxemia which exists over long periods of time; the infection taking place in childhood and the disease showing alternate periods of activity and quiescence, persisting oftentimes for many years before manifesting itself as a clinical entity. While the disease may not be sufficiently pronounced to be recognizable, yet there are many times during this long period when the toxins are being formed and set free into the blood stream in such quantities as to produce ill effects. The toxins exert their injurious effect upon the central nervous system. The nerve cells, as mentioned above, are influenced by stimulation; and, according to the nature and the amount of the stimulation, they react normally, or are influenced adversely. They react to normal stimulation with a natural response; but, if they are more or less constantly subjected to such abnormal stimulation as that produced by toxins, they must suffer injury; and such injury, of necessity, is followed by abnormal action. Therefore, it is not surprising that we recognize a perversion of normal nerve activity and disturbed function on the part of many organs in tuberculosis. This disturbed function is particularly noticed after clinical tuberculosis has been present over a prolonged period of time. Chronic clinical tuberculosis exists in the average individual for a period of three or four years before death ensues, in case the disease goes on to a fatal termination. The influence of the toxins becomes more manifest as the disease progresses, and shows as a general derangement of the body mechanism and a general disharmony in cellular activity throughout the entire organism. In many patients the focus has been partially active throughout the life of the individual, and has been intermittently giving off toxins which have produced harmful stimulation of the nerve cells.

Disturbed function manifests itself not only in emotion and sensation but in thought as well; because thought depends upon and is altered according to past experiences which the individual has undergone, the same as sensations and motion; consequently, the patient suffering from chronic tuberculosis suffers from both neurasthenia and psychasthenia. He is typical of those of these classes in every sense of the term. He suffers from lack of nerve force, as far as his motor acts are concerned, his sensations are likewise disturbed and his method of thought is perverted.

The lack of power for muscular action in the chronic toxemia of tuberculosis, is evident to all. Disturbed sensations are not so evident, but nevertheless, are present. Disturbances in mental processes, while not always observed, are very plain in some cases. That there should be this disturbance in mental processes is evident from the fact that one's beliefs and convictions on any subject are the sum of the suggestions which have been retained by the brain cells, modified by one's previous experiences; consequently, we must not expect the patient who is suffering from such a chronic toxemia as that of tuberculosis, to have absolutely correct conceptions. His brain cells have been bombarded with toxins over a prolonged period of time; and, as a result, are disturbed, to a certain degree, in their function; consequently, we are not surprised when we find such a patient in a chronic depressive psychical state. Psychotherapy is of great aid to such patients. It helps them to see that their method of thought is abnormal, and that its cure depends largely upon themselves. Such patients are helped far more by wise suggestion than by physical or chemical measures. Each measure, however, relieves to the extent that it can shield the nerve centers from harmful stimuli.

Not only do we recognize the influence of education and past experience upon the individual and his mode of thought and action; but we know, from physiologists, that there is a marked difference in effect between the emotional states of a hopeful, optimistic, cheerful nature, and those which are depressive and pessimistic. As I have previously mentioned, all depressive emotions stimulate the sympathetic nervous system, and, if prolonged, keep up a general inhibiting effect upon the various organs under its control; and, at times, permanently interfere with their activity. Where the effect upon the nerve cells has not yet been made permanent, this condition can be relieved by dispelling the depressive emotions. This can be done by suggestion. By it we can produce mental impressions which will relieve the irritation of nerve cells, which permits a generally improved function throughout the organs supplied by the vegetative nerves. Particularly do we note improvement in appetite and in the secretory and motor activity of the gastrointestinal tract. Improvement, however, is not confined to any single organ, but the metabolic processes of the body generally are stimulated, as is evidenced by the general improvement in the nutrition of the patient.

There is no remedy at our command which is more generally applicable than psychotherapy. In this respect it equals open air. With it we relieve the depressive emotional conditions, remove fear, discouragement, discontentment, anxiety, and worry, and put the patient in a happy, contented, optimistic frame of mind, and in this way directly improve the physiological action of all viscera supplied by the vegetative system and indirectly stimulate general cellular activity.

The patient suffering from chronic clinical tuberculosis is an ideal subject to be treated by suggestion or psychotherapy. The physician who is most successful in handling these patients is not, necessarily, the one who knows most medicine; but the one who always bears in mind the personality of his patient, considering him as a thinking, hoping human being, to be led into paths of correct thought and action.

A physician will usually obtain better results if he has confidence in the methods that he employs. He conveys his ideas to the patient, stimulating in him a spirit of cooperation and trust. The physician, on the other hand, who approaches his patient in a spirit of doubt, as a rule, conveys his lack of confidence to the patient, thus depriving him of the essential for cooperation,—confidence. The physician totally fails to understand his patient who thinks that he will cooperate in a prolonged course of treatment without being stimulated by hope of a favorable result as a reward. Any measure carried out with the force of the physician's personality and confidence back of it will have a far greater influence than a more meritorious measure which is employed in a mechanical way. The enthusiasm and optimism which one puts into his work is conveyed to the patient and creates in him a sense of satisfaction and a spirit of confidence, loyalty, and trust, which relieves states of depression which would otherwise retard progress.

Psychotherapy has a wide and important action in the treatment of tuberculosis. As pointed out in my discussion of the principles underlying the treatment of tuberculosis, as yet there is no specific remedy which can be employed in the cure of this disease. It is our purpose, in carrying out a line of treatment, to build up the patient, increase the reactive and resisting power of his body cells, so that when he comes in contact with tubercle protein he will react strongly in the formation of specific proteolytic enzymes. This is the essential feature in the creation of specific immunity against the tubercle bacillus, and is produced by the body cells themselves. It is true that another important factor in healing the diseased focus, after it exists, is the specific focal reaction which is produced, either by the protein or the bacilli within the patient, or, by the bacillary products introduced from without.

Psychotherapy belongs in that class of remedies which aids in the cure of tuberculosis by improving the general cellular activity like open air, food, rest, and exercise, and various forms of baths—air, light, or water. It increases resistance by improving the activity of the body cells and stimulating metabolic changes.

It keeps the cells in such a state of normal equilibrium that they are able to react and form the greatest number of specific proteolytic enzymes, when they are stimulated by bacillary protein. In order to explain this action more specifically, it is necessary to recall that tuberculosis is accompanied by a chronic toxemia; that the ill effects, for the most part, are due directly to the tuberculosis and are of toxic origin, and that they express themselves upon the central nerve cells, but have a particular effect upon the sympathetic system, producing a general disturbance in the function of all organs, which are supplied by this division of the nervous system. The structures which are supplied by the sympathetic nervous system are also deleteriously influenced by the depressive emotional states such as fear, discouragement, anxiety, discontent, and worry. The effect upon the function of the various structures, produced by these emotional states is similar to that produced by toxemia. There are times during the activity of the disease when toxemia cannot be relieved; but, if any of these depressive emotional states are present, they may be relieved by proper psychotherapeutic treatment, and the patient may thus be relieved of the harmful stimulation of his nervous system which depends upon them. This may be sufficient, under many circumstances, to restore a degree of equilibrium in the organs and tissues involved and allow the body functions to be carried on in a manner approaching sufficiently to normal to permit of a storing up of more energy than the patient is using up in combating the toxemia present. Under such conditions the metabolic balance will be established in favor of the patient and improvement is bound to ensue.

Psychotherapy cannot effect the mechanical results which are produced by the tuberculous process; but it can greatly improve the physiological processes whose action depends upon normal stimulation of the nervous system.

How to Apply Practical Psychotherapy for the Tuberculous.—The influence of suggestion should be utilized at the first visit of the patient. The physician should proceed to examine the patient in a manner which demands the patient's confidence. He should be exact in his methods and make his examination sufficiently complete to be able to give the patient a comprehensive idea of the disease process from which he is suffering. I think physicians very often lose an important advantage over the patient by showing him that they themselves do not understand the case. If they do not, they should not give an opinion until sufficient examination has been made upon which to base a definite conclusion.

The method of telling a patient of his trouble has a great deal to do with his mental attitude; consequently, the physician should study how to tell the patient of his trouble in an easy and humane way; how to take away the sting that comes from the knowledge of the existence of a chronic serious disease like tuberculosis. At this time he should imbue him with hope. He should tell him of the curability of the disease; how proper guidance and faithful cooperation will bring a result in a large proportion of cases.

He should further discuss the subject with the patient in such a way as to show him what course the disease will probably take. He should prepare him for periods of activity, which are almost sure to come, and should explain to him that these are a part of the general process; that the results are not necessarily serious, and that such periods of activity may come and not be inconsistent with the ultimate obtaining of a favorable result. The greater the degree of intelligence with which he discusses the problems before the patient, the more he will be able to obtain his confidence and the greater reassurance he will be able to give him.

I have always found it advantageous to tell my patients that, under no circumstances, do I promise to cure them. Proper therapy, carried out with a spirit of faithful cooperation, will produce results in a great many instances; but, I might do my part well, and the patient might do his part faithfully, and yet we might fail to obtain the desired results; but, if both physician and patient cooperate fully, defeat can often be turned into victory. This shows the patient that there is no attempt at concealment; and both he and the physician enter upon the treatment with a frank understanding which engenders confidence and trust. The patient understands the necessity of cooperation and the dangers of failing to do his part.

In dealing with the neurasthenic side of the tuberculous patient, I explain to him that his nerve cells have been bombarded by harmful stimuli for so long that they act abnormally, and that such abnormality may be improved and at times largely corrected by proper therapy. The neurasthenic state, fortunately, is brought on and continued by many other factors than the tubercle toxins, and while the toxins may not be relieved at once, not infrequently we are able to remove other factors, thus creating an increased nerve stability.

I put my patients at rest physically and then teach them how to obtain nerve rest. I urge upon them periods of relaxation. Rest means nothing to the average patient. One will think he is resting when he is sitting in a chair; another when visiting; still another when reading; but all of these may use up an amount of energy too great for the patient; and, if engaged in too strenuously, may prove as disastrous as walking and other light physical exercise. I recommend to my patients that they lie flat on the back, without pillows, beginning with a few minutes and increasing to two hours a day, or even more. I teach them not to read, or sew, or knit, or visit, or do anything continuously; but, if they do these things, do them interruptedly; carry on the activity for a few minutes and rest a few minutes, trying to relax thoroughly between times. A program such as this gives the nerves not only the rest that they have during sleep; but a rest during a considerable portion of each waking day. I explain to them that they must not worry; they must be contented; they must not have fears or anxieties; but believe what I say and look forward to general improvement. I explain to them how maintaining a state of happiness and optimism relieves the nerve cells of harmful stimulation; how the cells under this relief will regain, at least to a certain extent, their equilibrium. I explain it to them figuratively in this way:

The nerve cells, under ordinary circumstances, require 100 per cent load to discharge them; but, in states of neurasthenia and psychasthenia, which are common in tuberculosis, they are discharged by a much lower stimulus, probably 50 per cent, and, in some cases 25 per cent of the normal. Every method that may be employed to lessen the injurious stimulation to which the nerve cells are exposed will, to that extent, improve the equilibrium of the nerve cells and permit the point of discharge to approach the normal. In one case we may relieve the toxemia due to tuberculosis; in another we may relieve the toxemia due to intestinal stasis and constipation; in a third case we may relieve the harmful stimulation due to depressive emotional states and wrong methods of thought. The degree of relief afforded by any of these or by all combined may be sufficient to raise the point at which the nerve cell discharges to 50 or 75 per cent of the normal, or even to normal. The patient understands this explanation, although it may not be absolutely scientific.

I point out to him at each successive visit, the improvement that I note. In a case of neurasthenia or psychasthenia one should never fail to point out the particulars in which the patient is better, whether it be improvement in sleep, improvement in constipation, or a lessening in the amount of general complaint. These patients after a little bit forget to complain; and, as they forget to complain, their method of thought changes. It becomes more healthy. This form of positive suggestion to them aids greatly, and, after a short time, they, themselves, are forced to see the improvement, even though they may refuse to see it at first. It is with great pleasure that I tell a patient: "You do not complain as much as you did," "You are sleeping better," "You are eating better," "The pain which you had in your back does not bother you as much as it did." Then I call attention to the fact that this is what I told them would occur.

It is a mistake to find fault with a nervous patient. It is far better to compliment him on his effort as well as his improvement. Let him know that you have faith in him; that you believe that he is trying to cooperate; that you appreciate the efforts which he is making; and that you realize that it is difficult to do these things. Such an attitude of confidence in your patient begets confidence on his part and inspires further cooperation. The patients feel that they are repaid for the effort they are making. By such a method, one is able to gradually lift them out of themselves, improve their method of thought, create in them a spirit of optimism and hope, and thus lead them to a higher plane of thinking and living.

Not only is it a pleasure to lead patients of this kind to a higher plane of efficiency; but, if it can be done, it will prove to be one of the greatest points in retaining an arrestment of their disease when it has been attained. The physician leaves his work half undone if he cures an early tuberculosis, but leaves the patient still in a neurasthenic state.

Psychotherapy is particularly valuable in those patients who are poor eaters. This class is made up almost wholly of frail girls who are poorly nourished and markedly lacking in physical endurance. The diet of such girls is nearly always insufficient. They have little appetite and it is usually capricious. Anxious friends are apt to cater to their whims instead of helping them to form correct habits of eating. They encourage them in persisting in their fancies and whims. Salads and sweets, with a few bites of substantial food, make up the dietary of many of these girls. They eat whenever they want to and, if they do not feel like eating, very often they make a cup of coffee or tea with a little toast, take the place of a meal. I have never been able to obtain a cooperation on the part of these patients by simply telling them what they should do; neither have I accomplished this by scolding; but I have succeeded by a method of encouragement. I have such patients keep a record of what they eat. When they find it necessary to bring the list to me for careful inspection each day they themselves will soon see how little they are eating and how far short it falls of a proper dietary, and they, of their own accord, will begin to try harder. The physician should carefully notice each improvement, no matter how slight, and encourage the patient by complimenting him on the result of his effort. Such a method will nearly always produce the desired result and aid the patient in correcting his habits of eating.

Psychotherapy can be directed toward any important function of the body, whether it be an abnormality on the part of the motor system, sensory system, or abnormal habits of thought. The action of the various internal organs can all be largely influenced by proper suggestion. A better state of cellular activity will be engendered and, as a result of this, the cellular metabolism of the entire organism will be favorably influenced.

CHAPTER XLII.

HYDROTHERAPY.

Physiological Principles.—From our description of the physiological action of open air and the various factors which go to make up climate, it will be recalled that the human organism is greatly affected by physical influences exerted upon the body surface. In order to fully realize these influences we must recall that every cell of the body is connected, through the nerves, with the central nervous system, and, in the central nervous system the various cells are indirectly connected by reflex paths with other cells. The afferent impulses travel from the surface of the body to the cord and stimulate muscular action in superficial tissues or in the deep organs within the body. Likewise afferent impulses travel from the internal viscera and reflexly affect either internal viscera or superficial structures. So, our conception is that there is a continuous stream of impulses resulting from physical action upon the surface of the body which flows toward other somatic structures or toward internal organs; and from the internal organs toward other internal organs or external structures. The underlying principle of all therapeutic measures which have their application to the external surfaces of the body such as poultices, counter-irritants, air, light, water, and electricity are based upon this fact.

Kellogg[1] says: "The skin is without doubt one of the most important and interesting of all the sense organs, being provided with a greater variety of nerves than any other portion of the body. The nerves which supply the skin are the following:

"1. The nerves concerned in the tactile sense: *viz.,* those which recognize *pressure* and *locality.*

"2. The two sets of nerves concerned in the *temperature sense,* which terminate in the skin in the so-called *hot* spots and *cold* spots.

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[1] Rational Hydrotherapy, F. A. Davis Company, Philadelphia, 1901.

"3. Nerves which recognize *pain.*
"4. *Vasoconstrictor* nerves.
"5. *Vasodilator* nerves.
"6. *Sympathetic* nerves."

Thus, it may be seen that the influence from the standpoint of the nervous system is a varied one and general in its action.

Blood and lymph as they may be influenced by measures applied to the skin, play a very important part in all forms of application to the skin. It was formerly thought that the body contained about thirteen pints of blood. It is now known that this is somewhat too large. The tissues contain three or four times as much lymph as blood, consequently, all body cells functionate in liquid media. The movement of the blood and lymph is very important in carrying on the processes of metabolism. The muscles of the body are able to contain half of the blood and a very large proportion of the lymph of the body. The skin is richly supplied with vessels, the capillaries being arranged in small loops in order to better carry on their particular function. The effect of muscular action upon the circulation throughout the body, and particularly in the skeleton muscles and muscles of the skin, is very important. By them, circulation of the blood and lymph is hastened. Fluids are literally squeezed out of the tissues by muscular contraction. All physical forces which act upon the skin, influence circulation. While all action is through the nerves, yet the particular influence upon the movement of the body fluids must be borne in mind in considering the effects of hydriatic measures.

By the application of so simple a measure as water we are able to produce widely varied resultant action in organs far distant from the surface of the body. The effect of the water will depend upon its temperature and the degree of its impact. It will also vary according to the condition of the skin at the time of its application; consequently, water is a very elastic remedy, which should not be used haphazardly. It is one which has a definite action, according to the conditions which surround its application. While baths are applied locally to the skin, their effect is through the nerves to the tissues generally. This can be shown by severing the nerves which supply a certain portion of the skeletal muscles. After this, the part supplied becomes influenced by the temperature of the surroundings. If it is placed in cold water, or cold air, the part assumes the temperature of the water or air. If it is placed in warm water or warm air, the temperature of the part rises to the degree of the surrounding medium. When the nerves are not severed, on the other hand, cold stimulates metabolism and contracts the superficial vessels, and thus causes a rise of temperature in the part; while warmth dilates the vessels and favors dissipation of heat with reduction of temperature.

It is desirable in tuberculosis to have the function of the skin as active as possible. To this end we should give the skin careful attention. The functions of the skin are: receiving external stimuli and utilizing the favorable ones for the good of the individual and calling into action defensive forces to neutralize those which are harmful; protection; excretion; and absorption. There is some exchange of oxygen and carbon dioxide which takes place through the skin, but this is practically negligible in the human being. This is so marked in some cold blooded animals, such as the frog, that they may be able to oxygenate themselves after their lungs have been removed. Absorption takes place through the skin to a limited extent; and there is an elimination of certain poisons, which result from the metabolic activity.

Heat regulation, however, is a very important function; and one which is particularly important from the standpoint of health. The skin of the tuberculous patient partakes of the regional, as well as the general, malnutrition which is present during this disease. As I have shown elsewhere, the skin and soft tissues which are in reflex communication with the pulmonary sympathetics, are subject to degeneration and atrophy as the disease becomes chronic. Aside from this, however, there is a general loss of tone and degeneration, which affects all the cells of the body. The muscles waste, subcutaneous tissue disappears, and the skin thins as the disease progresses. If any measure can be adopted to improve the tone and function of the cells of the skin, it will be followed by beneficial influences upon the entire organism.

The degeneration of the skin and other soft tissues covering the skeleton causes them to react sluggishly to physical stimuli such as those produced by water and air; and, consequently, these fail to give the proper stimulation to the body, as a whole. If hydrotherapeutic measures are properly suited to the skin, it will improve its nutrition, and thus hasten the flow of blood and lymph through the superficial channels and bring a better nutrition to the part. As the nutrition of the skin improves, its functions are performed with greater perfection; the patient's reactive power to superficial stimuli is increased; and the metabolic processes within the body are stimulated. The patient becomes less sensitive to such external influences as cold. He becomes less liable to attacks of coryza, and less prone to harmful influences which result from chill and weather changes which, at times, reduce vitality, and render the individual subject to disease.

If the cells of the skin functionate properly and a good state of nutrition is maintained, the nerve endings which receive stimuli coming from without, and transfer them to the proper centers, respond more perfectly; and, consequently, increase the efficacy of bodily reaction.

The circulatory, respiratory, digestive, and nervous systems are all influenced by baths, and may be favorably or unfavorably influenced, according as the bath is properly or improperly suited to the patient. When the proper bath is given, circulation throughout the body is quickened and general metabolic activity is hastened; thus secretory and excretory functions become more active and the body, as a whole, functionates better. Thus, it can be seen that proper hydrotherapeutic measures are capable of rendering important aid in the treatment of individuals suffering from tuberculosis. In fact, water baths, air baths, and light baths can all be utilized to the advantage of the patient.

Conditions Governing Bath.—The bath must be carefully suited to each individual patient. Proper technic is the essence of hydrotherapeutic measures. The effect of the bath depends upon the condition of the patient, as well as the nature of the bath and the manner in which it is given. It is well to bear in mind that hydrotherapeutic measures, while apparently simple, call for reaction on the part of the body cells. This reaction may be slight and entirely within the patient's powers of response, or it may be marked and beyond them. In tuberculosis, conditions are present which lower the powers of response for the great percentage of patients; consequently, this must be borne in mind when adjusting the bath to the individual. Many procedures which would be distinctly valuable for those suffering from other diseases cannot be used without risk in tuberculosis.

The bath must be suited to the activities of the patient. As a rule, a cleansing bath should not be given soon after a meal. It is best that the bath should not be given until three or four hours after the meal is eaten, nor should it be given immediately before the meal. The tonic bath, however, may be given shortly before the meal, and be followed by light exercise, short of tiring, by those who have good reacting powers and who are in good physical condition.

Effects of Hot and Cold Baths.—The first effect of heat is as an excitant, but later it becomes a sedative and depressant. The exact effect produced depends on the conditions surrounding its application and the length of the application. A very short application of heat is exciting, but, if it is prolonged a sedative or depressing effect is produced. If the temperature of the bath is very high and it is greatly prolonged it may prove exhausting.

The effect of the application of cold is that of an excitant. If properly applied, so as to obtain its therapeutic effects, it is invigorating and tonic in character. If cold is applied to the body for a short time it proves invigorating and if repeated daily, in some such form as a cold sponge or spray bath, in accordance with the patient's powers to react, it has a decidedly tonic effect. The lower the temperature of the bath to which the patient will react, the greater the tonic effect. The tonic effect of the cold bath is greater if it is not prolonged. A short application of cold followed by a brisk rubbing, such a bath to be repeated daily, gives the greatest tonic effect.

Neutral baths, such as are taken with the water at or near the temperature of the body, produce practically no reaction, but have a calmative influence.

The influence of baths upon the dissipation of heat is important. Prolonged baths in water above the temperature of the body, prevent abstraction of heat and cause a rise of body temperature. Prolonged cold baths, on the other hand, abstract heat from the body and reduce temperature. If kept up sufficiently long they lower the vigor of the patient and prove exhausting.

Sometimes, where patients' reactive powers are extremely low, they may be quickened by preceding the application of cold by one of heat.

Reaction.—A simple, convenient, and safe way to determine the suitability of a bath is by observing the reacting power of the skin. A bath given for its tonic effect should leave the patient with a feeling of warmth and exhilaration. The superficial capillaries should be dilated, causing a glow. Unless this occurs one should suspect that the bath is not being given under proper conditions. A tonic bath should always be given when the patient is warm and while the superficial capillaries are dilated. This avoids chill and favors reaction.

When training a patient who has not been accustomed to the use of cold water, the temperature of the bath must be reduced gradually. The stimulation must be suited to the patient's reactive powers. The two main factors in the bath are the temperature of the bath and the mechanical effect upon the body. Cold put on the body without friction or without force, is much less stimulating, and calls for greater reactive power than cold applied with force and friction. It, at times, may overcome the reactive powers wholly.

The reaction of the patient will vary according to the temperature, friction, and the amount of surface wet at one time. It is wise in treating tuberculous patients, particularly if activity is present, not to wet too large a surface of the body at one time when giving a cold or tonic bath.

The reactive powers of the patient may be trained by taking water at the body temperature and gradually reducing the temperature, using water slightly cooler each day until the desired degree of coldness has been attained, always being careful that the temperature is not reduced beyond the patient's reactive powers. This is determined by the degree of dilatation of the superficial blood vessels, as evidenced by the flush or glow after the bath is completed. When warm water is not at hand, the bath may be graduated in a less accurate way by first dipping the hands in water and rubbing the surface with them, than taking a coarse wash cloth, wringing it fairly dry; and, later, taking a little more water; and, finally, using a cloth soaked with water. While this method of graduating the bath is more crude than the one of gradually reducing the temperature, it is practicable and can be utilized satisfactorily if the patient, or attendant, understands thoroughly what he is trying to accomplish. The rapidity with which the temperature of the water may be reduced, or the rapidity with which one may change from the friction of the hand to that of the dry cloth, and from that to the wet cloth, will depend entirely upon the individual patient and his reacting powers. If the skin at any time fails to glow satisfactorily, it should be taken as a warning that the limit of the reacting powers of the patient, for the time being, has been reached, or that the bath has been applied to too large a surface, or with too little friction; and attention to one or all of these details should be given.

It is best, under these circumstances, not to wet too large a surface at one time and not to reduce the temperature of the water until the patient reacts fully to the bath as given. Until the patient's skin is educated to reaction, it is best to wet only a small surface of the body at one time, and dry and rub it before proceeding to another portion.

Cold Sponge.—While there are many ways of applying cold for its tonic effect, there is no method better suited to the tuberculous patient than that of the cold sponge. Its adaptability depends upon the fact that it can be used for nearly all patients. The risk of wetting too large a surface and overtaxing the patient's reacting powers is avoided. It is simple in technic and can be applied anywhere. Nothing is necessary but a basin of water at the proper temperature, a wash cloth, or friction mitt, and a bath towel. Patients, who are strong enough to rub themselves thoroughly without becoming chilled, may give themselves this bath. This bath should not be given, however, to those patients with too great an amount of cough, for it is likely to be increased by its application. Often, where a patient cannot take the bath alone without exciting too great rapidity of the heart's action, too much cough or too great dyspnea, it can still be given advantageously by an attendant because the tonic effect is the thing desired in the bath—the exertion on the part of the patient is only incidental.

The best time for the cold sponge is on arising in the morning. The patient has been in a warm bed, consequently the capillaries of the skin are dilated and the conditions favoring reaction are present. Where the patient's reactive powers are low, I have, at times, ordered a drink of hot water and extra covers to be thrown over the patient for a short period in order to induce a dilatation of the superficial vessels before the bath is taken.

The patient should be instructed to begin the bath immediately on arising. The first effect of getting out of bed into the cold air is that of contracting the superficial vessels. The cold air acts the same as the cold bath, although not to the same degree; consequently, if the patient waits until the cold air has contracted the superficial vessels, unless his skin is active, he may fail to secure the desired reaction. A rough wash cloth is much better than a smooth one because it produces greater stimulation of the skin.

The mechanical stimulation of the skin is a very important part of the bath, consequently, the friction produced by the friction mitt and rough wash cloth offers a good stimulant to reacting power, and is especially valuable for patients whose vitality is low. Soft wash cloths and sponges are not at all suitable for this form of bath. In giving the bath, first, one arm should be rubbed, the water being applied with the friction mitt or coarse wash cloth; the application being made by a few rapid strokes. Then the arm should be thoroughly dried with a towel, gentle friction being used until the skin takes on a definite glow. It is best, in the case of patients with low vitality, to cover the part as soon as bathed. This is not necessary, however, in those who are more robust. Then the other arm should be treated in the same way. This to be followed by the front and back of the chest. The cold sponge may be confined to the chest, or, in patients whose reacting powers are good, it may be extended to the entire body. The greatest value is obtained in the use of this bath when it is given over the entire body. It requires only three or four minutes for the entire bath when given properly. After the bath, the patient should either return to bed; or, if his reacting powers are good, he can dress and move about. Patients who are able to walk often find a little exercise taken at this time very refreshing.

One of the important points of advantage possessed by this bath is that it can be suited to almost all circumstances. If warm water is to be had, the bath may be given by gradually diminishing the temperature, as suggested above; but, if not, the other method may be utilized. Patients who have access to a bath tub may take the cold sponge standing in warm water, to a depth sufficient to cover the ankles. This prevents chill and aids the general reacting power.

The patient's skin may be educated and his reacting powers may be sufficiently increased so that the water, within a week, may be reduced from body temperature to that of the water found in the faucet.

If the cold sponge is properly given the patient should feel warm and comfortable on its completion. The use of this bath is one of the safest and best methods at our command for hardening the tuberculous patient, insuring him against colds and all conditions which may be produced or aggravated by chilling. It improves the general neurovascular tone and has a wide effect in increasing cellular activity.

Spray Baths.—Many of the better homes today are equipped with a spray bath. The spray bath, when followed by the proper reaction is refreshing, and if repeated daily, proves to be an excellent tonic. There are certain conditions about it which are desirable and some that are undesirable, as far as the tuberculous patient is concerned. If both hot and cold water are present, and the spray is delivered with sufficient force, this bath can be utilized by patients, with early tuberculosis, to great advantage. Making a quick application of warm water first the superficial capillaries are dilated, and when followed by cold immediately afterwards, the desired reaction is almost positive to follow. For this bath, however, the patient's reactive powers should be tested and he should be trained with the care mentioned above in describing the cold sponge. For patients with advanced tuberculosis this form of bath is not desirable. It sometimes excites cough and it requires too much exertion to dry the body if the whole surface is wet at one time. This latter objection, however, is removed, where an attendant gives the bath.

Swimming.—Swimming is a form of bath that is not well suited to treating tuberculous patients. It is particularly contraindicated in those of low vitality and those who are in the advanced stages of the disease. The particular contraindications in tuberculosis are the facts that the temperature of the water cannot be controlled and the degree of exercise required in swimming cannot be gauged. The wetting of the entire surface of the body calls for strong reactive powers. While swimming is a pleasure and delightful pastime, it is too exhausting for the tuberculous patient to utilize this form of bath.

Tepid Sponge.—Hydrotherapy offers many different procedures which may be used for the purpose of reducing temperature. One that I have found most advantageous in treating the fever of tuberculosis is the tepid sponge. The patient may be greatly refreshed by a general sponging with tepid water. Since our modern studies, however, show that temperature *per se* is not harmful, but that it is definite evidence of the reacting power of the patient against the toxins which are being liberated in the body, our desire to lower temperature has greatly lessened. It is a custom from which I rarely depart to use no measure for the lowering of temperature except air. By covering the patient lightly, a free circulation of air about the body is permitted and the abstraction of heat is facilitated. I sometimes augment this action in summer by directing a current of air upon the patient, generated by an electric fan. This, however, must be done cautiously so as not to cool the surface too much. Regardless of the fact that temperature does not have the harmful influence that we once thought, we oftentimes can add greatly to the comfort of the patient by the use of tepid sponging. Headache may be relieved, and the patient may be greatly refreshed by the application of water to the face and head. At times sponging the hands will relieve nervousness and have the same general soothing influence upon the patient as sponging the surface of the body. Tepid water seems to me to relieve symptoms better than cold water and does not have so much tendency to produce chilling. Where feelings of chilliness are produced by either a water or air bath they should be discontinued.

Wet Jacket.—The wet jacket is of value in many cases of irritating paroxysmal cough. The method of its application is as follows: The jacket is made by sewing three or four thicknesses of old linen together. It is made to fit close up to the neck, and to extend to the lower edge of the ribs. Holes are left for the arms. The sides are brought forward so as to lap in front. It is important to have it fit as accurately as possible. This is wet in water at room temperature (70 degrees Fahrenheit) and put on with care. It is then covered by another jacket made of flannel, whose edges overlap in all directions. This then should be bound on by a cotton flannel bandage six inches wide and about ten yards long. This bandage may be put on immediately over the linen jacket, but it is best to cover the jacket with dry flannel first. Care must be used that all edges are carefully covered and the bandage wound sufficiently tight so that the jacket will stick close to the chest. If it fits loosely, air enters between it and the skin and produces chill. When put on correctly it is worn with comfort by the patient. After the first shock produced by the cold water applied to the skin has passed, the patient experiences a feeling of comfort and warmth. At times I have found it difficult at first to convince the patient that such a procedure could be comfortable and have any other than a deleterious effect upon a disease affecting the lungs; yet, after wearing it for a night or two the patient usually experiences relief, and time and again patients have begged me to continue its application. The wet jacket should be put on at night and removed in the morning and be followed by the usual cold sponge.

Throat Compress.—In case of tuberculous laryngitis, as well as acute inflammations of the throat, the compress has an important effect. The throat compress is made by sewing several thicknesses of linen together. It should be about four inches wide, the exact width depending upon the length of the patient's neck, and should be long enough to reach about twice around the neck. This should be wet with cold water and applied to the throat in such a manner that it fits snugly to the skin. It should then be covered by a piece of flannel, extending over the edges, or by a bandage of cotton flannel. The edges should be well covered, the same as in the use of the wet jacket mentioned above, so as to prevent the entrance of air. When applied snugly no chill results from its use and the patient experiences comfort and relief.

Cleansing Bath.—No matter what other hydrotherapeutic procedures are used, the cleansing bath is an important factor in tuberculosis. The cleansing bath should be taken twice a week. It has an important influence in keeping the skin clean and improving its general reacting powers. A cleansing bath should not be hot. The hot bath, as mentioned above, is relaxing and depressing and should not be taken unless ordered for some particular purpose. There is a general tendency for people to use their bath water too hot. The general sensation of comfort which is first experienced on getting into a hot bath is taken as being of more importance than the after effect. After a hot bath is taken there is usually a feeling of chilliness, while a feeling of warmth follows the cold bath. The proper temperature for the cleansing bath is about that of the body. The cleansing bath should always be followed by the cold sponge. In this way the patient comes out of the bath feeling warm and refreshed.

Foot Bath.—Many tuberculous patients suffer from cold feet which at times becomes annoying and produces great discomfort, so much so as to interfere with sleep. Owing to the stagnation of the blood current in the extremities in tuberculosis because of the general vasomotor disturbance which is common in this disease, conditions are present which are difficult to overcome until a circulatory balance is established. I have found, however, that those patients who suffer from cold feet can be greatly aided by hydrotherapeutic measures. I have them take a foot bath once or twice a day, first putting their feet in hot water, allowing the superficial capillaries to dilate, then plunging them into cold water; then alternating between hot and cold two or three times, finally removing them from cold water and rubbing them thoroughly. This measure, though simple, affords great relief.

Alcohol Bath.—While this subject may not rightly belong to the chapter of hydrotherapy, yet alcohol is used in baths, or for baths, to such an extent that it deserves special attention. The belief is quite common that tuberculous patients cannot take cold baths or water baths of any kind without running the risk of "catching cold;" and, alcohol baths are often supposed to prevent this. If alcohol rubs are not used, there is a general belief that if a little alcohol is put in the water it will prevent the patient from "catching cold." Others believe that it is necessary to follow the bath with an alcohol rub in order to protect against chill. All these ideas are erroneous. Not only is alcohol unnecessary, but it produces effects upon the skin directly opposed to those desired in tuberculosis. Physicians also share in the layman's fear of baths in tuberculosis, and are very prone to order the use of alcohol, according to one of the methods mentioned.

In the first place, as has been shown before, water, when properly used, is a powerful restorative and tonic measure. Instead of weakening the patient, it strengthens him, and increases his resistance rather than his susceptibility. A decided objection to alcohol is its drying effect upon the skin. One of the important benefits from hydrotherapy is the general improvement of the condition and reactivity of the skin. Alcohol, by its drying effect, injures the skin, thus producing the very conditions which we desire to avoid. Its use should be discouraged and the free use of water encouraged instead.

CHAPTER XLIII.

HELIOTHERAPY.*

Heliotherapy is the term employed to describe the therapeutic application of light to disease. This means light in its broadest sense and comprises all forms of solar energy.

Fundamental Principles of Light.—In order to understand light and its action upon the organism in health as well as disease, it is necessary to review some of the fundamental principles of light energy. While these can be obtained in books on physics, yet at the risk of repeating what is well known and without making claim to any originality, the writer will mention a few principles which will enable one better to understand light as a therapeutic agent.

It is necessary to understand that the sun is the source of all light and heat energy; in fact, it is the source, indirectly, of all energy. Some idea of the physical condition of the sun may be obtained from a quotation from Cleaves[1] in which she is describing Kirchhoff's conception, as follows:

''As an explanation of the occurrence of the dark lines in the solar spectrum, Kirchhoff concluded that the atmosphere of the sun encloses a luminous mass which emits a continuous spectrum of high illuminating power. This inner portion is either solid or liquid, and at a higher temperature than the atmosphere. Subsequent and more recent investigations, however, show that the sun is much more complex than Kirchhoff imagined. The nature of the *inner nucleus* of the sun can only be conjectured, as it is beyond the reach of observation. In all probabilities, it consists of a gas at an extremely high temperature, and under such an enormous pressure that its properties must resemble to some extent those of a viscous substance, like putty. Surrounding this nucleus is the *photosphere,* composed of glowing cloud-like masses of vapor; it forms the visible surface and appears to correspond with the clouds in the terrestrial atmosphere. It is unknown whether it is separated from the nucleus by a definite surface. Externally, it is sharply but irregularly confined, being elevated in some places into *faculæ,* and in others depressed, forming *spots.* The *reversing layer* is situated directly over the photosphere and produces the Fraunhofer lines. Its thickness is only about 1,000 miles. The gases composing the reversing layer are not confined exclusively to the surface of the photosphere. They also occupy the spaces between the photospheric clouds and constitute the atmosphere in which these float. Above the reversing layer is the scarlet red chromosphere, consisting of uncondensed gases,—hydrogen and helium. Numerous prominences extend from this far beyond the surface of the sun. The exterior portion of the sun is termed the corona, it consists of clouds and irregular streams of light and gradually merges into the surrounding darkness. The greater portion of the mass of the sun is within the photosphere, but the larger part of its volume is outside of it. The diameter of the solar atmosphere is at least double that of the central portion, and its volume consequently seven times as great as this. In the fact that the atmosphere of the nucleus of the sun is an atmosphere sufficient to volatilize metals, and also that the sun's mean density is low, there is found sufficient evidence for the belief that the nucleus of the sun consists of gas. As the temperature of the gaseous mass is far above its critical point, the high pressure must cause it to exceed water in density, and, therefore, the gases must be viscous and comparable in properties with molten glass or putty. The photosphere is undoubtedly a gaseous envelope, condensed in places into cloud-like masses of vapor, in consequence of the heat radiating into space. These masses account for its irregular appearance, and the solid or liquid particles of them cause luminosity and produce a continuous spectrum, like the solid particles of an ordinary flame."

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[1] Light Energy: Its Physics, Physiological Action and Therapeutic Applications, Rebman Company, New York, 1904.

*The basis of this chapter is a paper which was published in the *Interstate Medical Journal,* vol. xxii, No. 8, 1915. It has been amplified and reconstructed in order to make it more complete.

Light energy consists of vibrations as does sound energy. White light is a combination of all the colors of the spectrum. Each color has its particular rate of vibration and its particular wave length. The spectrum consists of red, orange, yellow, green, blue, indigo and violet light, which are visible to the eye, and rays of longer vibration than the red, and shorter vibrations than the violet, which are invisible. The latter, while invisible are still potential. These various colors of the spectrum differ not only in wave length and rapidity of vibration, but also in their action.

Red light vibrates at the rate of 481 billions of oscillations per second; orange, 532; yellow, 563; green, 607; blue, 653; indigo, 676; and violet, 764. The invisible infra-red vibrates less than 481 billions and the ultra-violet more than 764 billions per second. Ultra-violet frequencies become shorter and shorter and merge into Rœntgen waves. Accordingly, as various substances adapt themselves to these vibrations, they appear to us as being of different colors. The color depends upon the absorption and reflection of light vibrations. A substance which is tuned, so to speak, to absorb all wave lengths except those of 481 billions per second, would appear red because these vibrations would be reflected to the retina. Each wave length, as it is reflected, shows as its own color.

It is of importance to understand that the nature of energy engendered by these various rates of vibration differs materially. While light is light, yet the light ray means much more than this. It means luminosity, thermal and chemical energy. These in turn depend largely upon the rate of vibration of the wave.

Light from different sources furnish different spectra. In sunlight, the heat rays are found in the entire spectrum, but they greatly predominate in the colors of long wave length, red, orange, yellow and green. The light rays are found in that portion lying between orange and indigo, with the maximum in the yellow. Chemical activity ranges from the yellow to the ultra-violet with the maximum activity being just short of the violet. The ultra-violet should possess the maximum chemical activity, but on account of the great absorption which takes place in these rays during their progress through the atmosphere, the maximum chemical action of sunlight is found short of the ultra-violet rays. This statement cannot be made without some modification, as the amount of ultra-violet rays which reaches the earth in different places varies greatly.

In passing from the sun to earth, the rays suffer great loss in energy. This loss is greater the shorter the wave length, hence chemical energy suffers more than thermal energy. Among the substances which cause the greatest absorption of chemical energy during their passage from the sun to earth, are oxygen and nitrogen of the air. Such constituents as water vapor, carbonic acid, and dust, also act as absorbents. Inasmuch as the sun's rays pass through a much thicker layer of atmosphere in the morning and evening when the sun is low, than at mid-day when the sun is vertical, the chemical rays suffer a correspondingly greater loss in the morning and evening than at mid-day.

Cleaves[2] quotes Young as saying: "It may be estimated that at sea-level in fair weather, neither excessively moist nor dry, about 30 per cent of the solar radiant energy is absorbed when the sun is at the zenith, and at least 75 per cent at the horizon. Of the rays striking the upper surface of the atmosphere, between 40 and 50 per cent therefore are generally intercepted in the air even when there are no clouds."

Langley[3] found that the following percentage of the various colors of the sun's rays passes the atmosphere unabsorbed. It is not stated where these observations were made.

Ultra-violet	39 per cent
Violet	42 per cent
Blue	48 per cent
Greenish blue	54 per cent
Yellow	63 per cent
Red	70 per cent
Infra-red	76 per cent

While the heat rays of the sun pass though the atmosphere, they do not give off heat to any great extent except by radiation after impinging upon objects; consequently, the heat at earth is partially absorbed and partially reflected, and we have a warm medium of air surrounding the surface; while the atmosphere which is distant from the surface is cold. The reason for this is that dry atmosphere (and that is the physical characteristic of atmosphere distant from the earth's surface) possesses marked diathermancy, permitting the rays to pass through without retaining the heat.

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[2] Loc. cit.

[3] Quoted by Freund: Elements of General Radio-therapy, Rebman Company, New York, 1904.

Sunlight contains large quantities of chemical energy. Even ultra-violet rays are plentiful in those places where the atmosphere is clear and the sun is bright, such as in the mountains, in the dessert, in the semi-arid regions, and at sea. Smoke prevents the passage of the ultra violet rays to a great extent, consequently the light of country districts is much stronger in ultra-violet light than that of cities. Haze and mist also interfere with their passage. Chemical rays are very strong at the seashore, and on large bodies of water generally, owing to the clear atmosphere, and the water acting as a reflector for them. This accounts for the intense burns which are so common on or near the water, and the extreme pigmentation which occurs when the exposure is prolonged.

Physiological Effects of Light.—Light produces different effects on different plants; some grow only in bright light; others grow only in the shade; and still others grow only under water. The action of the various rays is different. The heat rays favor plant growth while the chemical rays retard it. It is most favored, however, by green and yellow rays.

Bacteria are not killed by the heat end of the spectrum, while they are killed by the chemical rays, particularly the blue, violet, and ultra-violet. This destructive action seems to be partly due to a direct influence on the media in which the bacteria exist, and partly to a direct action on the protoplasm of the microorganism. While the heat energy does not destroy bacteria it renders the chemical rays more active.

While microorganisms are unfavorably influenced by light, living organisms which are infected by them are favorably influenced by it in withstanding their deleterious effects and are aided in throwing off infection. This has been proved by comparing the effects of bacteria on animals left in the dark, after infection, with those kept in the light.

The action of light on animals is a very complex one. It quickens all vital forces. It stimulates the body cells and improves the functions of the organs. This action is either direct or through the blood, nerves and organs of sensation.

The effect of light on the skin is that of a stimulant or irritant, according to the time of exposure and the intensity of the light. If the skin is exposed to intense light for a long time it may become acutely inflamed; an erythema, or even blister, resulting. If the exposure is more gradual, instead of acute symptoms, a hyperemia ensues which is followed by hardening and pigmentation of the skin. This pigmentation is protective in nature and interferes with the further penetration of the rays. Both erythema and pigmentation are a result of chemical rays and are produced more quickly and more generally where the ultra-violet rays are found in greatest abundance. It is possible that some chemical rays exist in rays of all lengths.

One of the most important actions of light upon the skin is associated with a dilatation of the capillaries which it causes. In patients whom I have treated with chemical rays from sunlight focused from large mirrors in which the heat rays were cut off by blue glass, the dilatation has remained, as has the pigmentation, for as long as three years.

The question of penetration is important. How deep will light penetrate? Inasmuch as the most important portion of the spectrum from the physiological standpoint is that which produces chemical action, we will confine our discussion almost wholly to this. Unfortunately, the most active portion of the spectrum, therapeutically, is the ultra-violet,—the one which is absorbed to the greatest degree in passing from the sun to the earth's surface. Chemical action, however, is not confined to the rays of short length. We must conceive that both thermal and chemical action are found, to a certain extent, in waves of all lengths. Under certain conditions, green, red and infra-red will produce photographic action. Chemical rays will pass through the body tissues. Sensitized paper has been blackened by chemical rays after passing through the ears of rabbits. Solutions of nitrate of silver introduced under the skin of the dog and cat have also been blackened. Likewise light has been shown to pass through the human hand.

Gebhard placed a photographic plate in the hollow of the palm. It was imbedded in plaster of Paris, and after exposure to an electric arc the plate was removed and developed. The picture of the hands and fingers was distinctly seen, showing that the light had penetrated. Kime has shown that light will pass through the human thorax and produce images on a photographic plate.

We have been led to believe in most of our discussion that these photographic results were produced by the chemical rays at the violet end of the spectrum; but Cleaves does not accept this; but looks upon it rather as being proof of the chemical action of the red waves, inasmuch as most of the shorter waves are undoubtedly cut off by the tissues through which they would be compelled to pass. It is very important to remember in the practical application of light in therapy that the penetration is not instantaneous. While penetration of a rabbit's ear or the human cheek might take only a few minutes, it is necessary to expose the human hand twenty minutes and the thorax still longer.

Light has an important action upon the blood. Waves of all length are absorbed by it. Tissues containing blood greatly hinder the passage of the ultra-violet rays, as is shown by Finsen's experiment of placing sensitized paper behind the ear and observing the action of light upon it. After five minutes no blacking was noticed when the tissues were full cf blood, but after twenty seconds blackening was shown when the tissues were pressed between glass plates so as to express the blood.

As a result of the light bath the superficial vessels of the skin are dilated, bringing large quantities of blood to the surface which absorb the light energy, resulting in changes in the amount of hemoglobin and an increase in the number of lymphocytes as shown by Taylor,[1] which increases the patient's resistance to tuberculosis as shown by Murphy and Sturm.[2] Light energy is also transmitted to the blood elements, increasing their fluorescence.

It has been shown that hemoglobin gives off its oxygen more rapidly in light than in dark, consequently light augments the oxydizing power of the blood.

Tissue change goes on more rapidly under the influence of light. This is probably due both to its action on the blood and the stimulation of the nerves. At times this is so rapid as to cause a loss of weight in animals subjected to continuous bright light.

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[1] Taylor, Herbert D.: Effect of Exposure to the Sun on the Circulating Lymphocytes in Man; Jour. Exper. Med., 1919, xxix, p. 41.

[2] Murphy, J. B., and Sturm, Ernst: Experiments on the Rôle of Lymphoid Tissue in the Resistance to Experimental Tuberculosis in Mice, Jour. Exper. Med., 1919, xxix, p. 35.

Muscle contraction is stimulated by light, and animals are enabled to do more work when they live in light than in the dark. The hibernating animal wisely chooses the dark for his winter home and thus lives with the least expenditure of energy.

From the description of light thus far, it can be seen that it has a decided stimulating effect on the organism. The difference between stimulation and irritation is only a difference of degree. While even a very active light can be utilized to the advantage of the human organism, both in health and disease, yet, at times, the light is so active that it proves harmful. Experiments show that exposure to intense rays will cause a loss of weight as mentioned above, and increased nervous irritability. Both these conditions, particularly the latter, are often met in human beings, whether healthy or ill, who live in the clear atmosphere in the high mountains, or dry desert regions. We see the same thing, though to a lesser degree, in certain regions in California which are back a few miles from the coast. This irritable effect must be borne in mind in prescribing climate.

Therapeutic Application of Light.—The question arises, can this intense energy found in light be utilized in the treatment of disease? If so, in what diseases and in what manner?

Without going into particulars, it can be seen that those diseases which may be benefited by a general improvement in tissue tone, and those superficial pathological conditions which may be improved by a hyperemia and increased bactericidal action, are especially suited to light therapy. Acne rosacea, acne vulgaris, sycosis, furunculosis, and lupus, are some of the bacterial skin affections which have been successfully treated. Syphilis, many of the nervous diseases, all forms of tuberculosis, anemia, and many other affections calling for general tonic treatment have been improved by light therapy.

It is well to bear in mind in the discussion of light in the treatment of any disease like tuberculosis, that it has no specific action. It is not a cure for tuberculosis. It is only one means of making the patient stronger and more resistant to the infection, except in superficial tuberculous infections where two other factors enter—namely, the hyperemia produced by it and the direct germicidal effect of the chemical rays. Knowing the readiness with which the chemical rays of the spectrum are absorbed by the blood and tissues, we must not expect a high degree of direct bactericidal action where the pathological process is situated deep in the tissues.

Light therapy was first popularized by the work of Finsen in the treatment of lupus. It has been taken up by many other observers in all parts of the country and used to a greater or lesser extent; but there has been no single worker who has given such great impetus to light therapy as Rollier. His experience was largely in the treatment of tuberculosis of the skin, bones, and joints. He evolved a gradual method of exposing individuals, particularly children, suffering from these forms of tuberculosis, to the sun's rays in the high Alps of Switzerland. Beginning with the exposure of a small portion of the body for a few minutes each day, he gradually increased the area until the entire body was exposed; and the time of exposure until it amounted to an hour or more each day. Such an improvement in metabolism and general resistance to weather conditions was gradually developed, that these patients were able to withstand exposure to intense cold without experiencing harm. Following the application of heliotherapy in this manner unusual results were obtained; in fact, the results proved to be so evident and so striking to those who visited Rollier and saw his work at first hand, that they became greatly enthused with the efficacy of this line of therapeutics.

We must not forget, however, that there is another strong factor in Rollier's treatment, and that is the influence of psychotherapy. While I do not wish to detract one iota from the value of this particular method of increasing the patient's general resisting power, yet I do wish to call attention to the fact that it is more valuable when given to a patient who is enthusiastic, optimistic, contented, happy, and hopeful than when given in a sort of experimental way, without the force of psychotherapy back of it.

There is some doubt in my mind whether the direct application of heliotherapy to the part affected has as much influence as the effect of light upon the general metabolism. It would seem from the action of chemical rays upon the surface of the body that their action is not wholly beneficial because nature has so planned it that the chemical rays, acting upon the skin, deposit a pigment which interferes with penetration. It would seem that the aborigines, who live in countries where the action of the sun is strongest, are all protected by a deposit of pigment in the skin; consequently, I think we are justified in drawing the conclusion that pigmentation is a protection, and evidence of the fact that man was not intended to stand too large doses of the chemical rays of the sun spectrum. They must be looked upon as a part of the general mechanism of adaptation.

This, together with the fact that the patients seem to improve equally or, as Rollier says, even more, after the pigment is deposited, would seem to indicate that a very large proportion of the therapeutic action of the sun's rays is spent upon the tissues, nerve cells, and vessels which are found in or immediately beneath the surface of the body. Students of light energy believe that the pigment acts as a transformer,—receiving light energy which contains less of the chemical strength, and transforming it into the more potent chemical and electrical rays. It is thus believed that the energy, which otherwise would not be utilized, is passed on into the deeper structures. Its effect in increasing lymphocytes has already been noticed.

The publication of the work of Rollier[4] in the application of light to tuberculosis of the bones, joints, and skin, has attracted almost universal attention. I have not had much experience in the treatment of bones and joints, but have for the past thirteen years been using light continuously in the treatment of pulmonary tuberculosis. I cannot claim the brilliant, convincing results in this form of the disease that are offered in the localized forms of tuberculosis; but yet the effect has been sufficiently marked to establish the importance of heliotherapy in the treatment of pulmonary tuberculosis. I have not employed light to the exclusion of other forms of treatment, because I do not conceive of it as being a cure for tuberculosis, but only an aid to be classified along with open air, good food, hygienic living, properly adjusted rest and exercise, hydrotherapy, and the proper mental attitude.

There are two methods which may be followed in the employment of solar energy. The patient may be stripped and the entire body exposed to the light, or the light may be reflected from large mirrors. When the mirrors are employed it is necessary to cut off the heat rays. This can be done by covering the mirror with blue glass which permits the reflection of the powerful chemical rays. These two methods differ greatly and are suited to different conditions.

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[4] Die Heliotherapie der Tuberkulose, Berlin, 1913.

The sun bath will vary in its efficiency according to its strength in luminous, heat and chemical rays. While the most profound effect on the blood and tissue changes depends on the chemical rays, or frequencies, yet the result must be looked upon as being due to a union of all of the three forms of energy. As the chemical rays are strongest in atmosphere which is clear and free from dust, mountainous, desert or semi-arid regions, and the seacoast or ocean surface offer stronger effects than other regions and are consequently more suitable for carrying out this line of treatment. Country districts free from smoke are far better than cities, and that portion of the day when the sun is more vertical, furnishes a much stronger bath than the morning and evening. All these factors must be borne in mind in adapting the bath to the patient. Only such regions as have a large percentage of sunshine are well adapted to light therapy.

The dosage of the sun bath is all important. A short bath has a decided tonic effect, while a prolonged one, if the heat energy is strong and not eliminated, will produce marked perspiration and have a depressing effect. If the heat can be eliminated by such means as cold douches to the surface, or artificially reducing the temperature of the surrounding air as is sometimes done in establishments for light therapy, or by cutting off the heat rays, then the full effect of the chemical rays can be obtained without the depressive effect.

The sun bath increases elimination through the skin, and in this manner should be a decided aid to tuberculosis, where so many factors are present which tend to increase toxin formation within the body. It stimulates general metabolic changes and through the blood and nervous system produces changes in most distant organs.

The effect of light on the blood is easily demonstrable. The city house dweller is pale compared with his country brother. In cold districts, people who remain much in the house are pale in winter and full-blooded in summer. Those who live in the intense light of the mountains, desert, and semi-arid and ocean regions are full-blooded compared with those who live in regions where the atmosphere is not so clear. This is well shown in children of our far West, South, and Southwest, compared with the pale children of other regions of our country. Light further improves the tone of the skin and acts as a general hardening factor, which is of great importance to the tuberculous in guarding him against colds and other acute respiratory infections.

When the atmospheric conditions are extremely favorable for light therapy, the exposure must be more guarded than when it is less favorable. The condition of the patient must be considered also. A patient with incipient or with inactive tuberculosis will stand the treatment well, but one with an active disease must be exposed very gradually. Inasmuch as in the ordinary sun bath it is usually impracticable to eliminate the heat rays, the dose of light must be regulated so as not to cause discomfort or marked increase of body temperature. The temperature will become somewhat elevated even in healthy adults after a prolonged sun bath; but in the tuberculous, in whom the vasomotor heat regulating system is always more or less disturbed, and particularly in those suffering from active disease in whom it is greatly disturbed, a very marked rise is apt to follow a too long exposure to the direct rays of the bright sun. Yet these patients can be given the beneficial effect of light if judgment is used. They cannot be forced too rapidly.

In our clear atmosphere in Southern California it is well to use the sun baths for those who are suffering from active tuberculosis, in the early morning, beginning at eight or nine o'clock according to the season, taking advantage of the fact that the rays at this time of day possess much less energy than they do later in the day. The morning is preferred to the afternoon because temperatures are naturally higher in the afternoon than in the morning. For those who are stronger and suffering from incipient, inactive or arrested disease, the baths may be taken nearer the middle of the day.

The length, as well as the extent of exposure, is important. The first exposure should be of only a small portion of the body, and should be for only a few minutes. The legs, arms, chest or abdomen may be exposed first. The part is apparently not so important in itself. Almost any patient with maximum daily temperature under 100° F. can stand an exposure of five minutes to any region of the body, except the head which should be protected; and this is the length of exposure that the writer would recommend as being safe for starting patients of this type. The length of exposure may be increased five minutes a day and the amount of surface exposed may also be gradually increased until finally the entire body is exposed for an hour. Sensitive patients or fever patients should be exposed to indirect light before direct rays are employed. Extreme judgment must be used, even in so seemingly simply a therapeutic agent as light. The patient must be watched. If weakness, faintness, headache, nausea, or any other symptoms referable to the light should appear, the exposure must be cut down in time or extent, or both. The head should be kept in the shade and it may be protected with cold damp cloths if necessary. Stronger patients, and those suffering from a less severe disease, may use the more energetic rays of the mid-day sun and may increase the exposure somewhat more rapidly, although they too must be careful not to increase the time or amount of exposure too rapidly.

When, on account of privacy, it is impracticable to expose the bare skin, very thin white garments may be worn. These will allow much of the light energy to pass through them, but such baths must in nowise be considered as being as valuable as those where the naked skin is exposed.

Blondes do not endure the sun baths as well as brunettes. Their skin does not contain as much pigment, consequently they are not so well protected and are more apt to burn. Care must be taken until the skin has hardened. According to the writer's observation, the blonde also shows more nervous irritability than the brunette when exposed to the sunlight.

Woodruff has discussed this in a very entertaining and instructive manner in a book which deals with the effect of light on races.[5]

The writer has had a larger personal experience in the employment of sunlight reflected from large mirrors (three feet in diameter),[6] than he has in the employment of the full sun bath. These mirrors are covered with a blue glass to cut off the heat rays. They concentrate the light on a focus about six or eight inches in diameter at a distance of about three and one-half feet from the reflectors. In this way there is a concentration of rays which affords a bath rich in blue, indigo and violet, and quite an increase in ultra-violet over what could be had in the general direct sun bath. If the patient sits in the sun, a large portion of the body is exposed to the direct rays of the sun during the bath and this proves to be a combined local bath of reflected concentrated chemical energy and a direct sun bath at the same time.

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[5] The Effect of Tropical Light on the White Man, Rebman Company, New York.

It has been the writer's habit to concentrate these rays on that portion of the chest of the patient which is the seat of the disease, beginning with an exposure of five minutes and increasing for five minutes a day, until an exposure of forty minutes has been reached. This limit seems to be about as much as can be well tolerated in the bright sun in our clear atmosphere. This should be varied, however, under other atmospheric conditions.

The effect of this form of treatment depends partly on the effect on the skin and superficial structures, partly on the effect on the nerve endings exposed and their reflex action, largely on the influence of the light energy on the blood which is bathed in it for this prolonged period of time, and partly on the penetration of the rays. It is impossible to ascribe to light the exact measure of its influence, for the patients are also receiving many other forms of therapy that have more or less the same effect.

One question worthy of consideration is, Do we get penetration, and if so, to what extent? Kime reports that he has reproduced photographic images through the normal chest with this reflector. Others report similar penetration with other methods of concentration of rays. Two experiences which make the writer think that penetration does take place clinically, at least to a limited extent, are first, a tendency to cough, which is often experienced by the patient if the early exposures, before the patient is accustomed to the treatment, are prolonged; secondly, a spitting of blood which sometimes follows too rapid and too prolonged exposure at the beginning of treatment. The writer has also noticed changes in the auscultatory note following an exposure as compared with the same note prior to exposure, but his later studies would cause him to question whether or not this might not be due to the changes which occur in the superficial tissues, since they are filled with blood as a result of the treatment. It seems that we may count on obtaining a fair degree of penetration by this concentrated bath, and if so, we are obtaining an effect much greater in energy than that produced by the simple sun bath when only the direct rays of the sun are employed.

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[6] The mirrors which the writer employs are especially adapted to institutional use. They were devised by Dr. Kime, of Fort Dodge, Iowa.

From his experience with light in tuberculosis, the writer would class it along with other tonic measures which build up the patient and make him more resistant to infection. It is not as universally applicable as open air, good food, hygienic living, hydrotherapy, optimistic surroundings and a carefully regulated life, because the particular rays which are most energetic in their therapeutic action, the chemical rays, are only found in large quantities in certain favored places where the atmosphere is clear, and are especially interfered with, in all regions where the atmosphere contains impurities, particularly smoke. Those who attempt its application in pulmonary tuberculosis will be disappointed if they expect to see certain immediate results. It is one of those matters which must be taken by faith. Knowing the physiological action of light energy, it appeals to us as being an aid, and as such it must be used. It must not be considered a cure for this grave disease. If it is, it will be another disappointment and soon be relegated to the past; on the other hand, if employed intelligently, with a full knowledge of its true worth, and a willingness to accept the measure of help which can be derived from it, it will take its place as one of the many measures which will help build up the sum of resistance in those afflicted with pulmonary tuberculosis.

CHAPTER XLIV.

ARTIFICIAL PNEUMOTHORAX.

General Consideration.—Artificial pneumothorax was first suggested as a therapeutic measure by Forlanini[1], of Pavia, in 1894. John B. Murphy,[2] of Chicago, independently of Forlanini, performed artificial pneumothorax, and reported his experiences in 1898. This therapeutic measure, however, received little more than local attention until it was taken up by Brauer and Spengler.[3]

When I first visited Davos, Switzerland, in 1905, Brauer and Spengler were then carrying on their investigations. After four or five years of observation, they reported their results in 1909.

Their report had extended over so long a period of time, and the cases had been so carefully studied, that this method at once assumed a position of importance in the treatment of tuberculosis. I have often said that if there could be something spectacular devised for the treatment of tuberculosis, or, if some method could be devised which could be applied generally, as the surgical and medical measures which are applicable to other diseases, then more rapid advances would be made in the treatment of tuberculosis.

At first it was hoped by many that artificial pneumothorax would have a general application and that it could be carried out by anyone who was versed in surgical technic; but such has not proved to be the case. After several years of observation it has been definitely determined that it requires careful diagnostic skill, as well as operative judgment, to successfully treat pulmonary tuberculosis with artificial pneumothorax.

One of the things which has made artificial pneumothorax appeal particularly to those who have had experience in the treatment of tuberculosis is that it offers hope for a class of cases which has not been generally successfully treated heretofore by other measures: namely, the acute destructive types of tuberculosis.

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[1] Gazzetta medica di Torino, 1894, vol. xv.
[2] Journal American Medical Association, 1898, vol. xxi.
[3] Brauer's Beiträge zur Klinik der Tuberkulose, bd. xii, 1909.

Artificial pneumothorax is usually stated to be the application of the theory of rest to the diseased lung. I think most people accept this as being the rationale of its action; but, if true, what are we to say of those areas which are not compressed? Surely they are not put at rest.

The Effect of Compression of the Lungs.—While artificial pneumothorax is most applicable in cases which are largely confined to one side, yet those who have had practical experience in the treatment of tuberculosis, know that a one-sided active lesion, particularly if the disease is far advanced in one lung, is almost always accompanied by some activity on the other side. If compressing the more seriously diseased lung is advisable in order to check the activity and heal the process there, what is to become of the other lung which, naturally, will be compelled to take upon itself extra work in order to carry on the function of respiration? If rest is the cause of the beneficial results obtained by compression we must accept the extra work which is thrown upon the other lung as being serious. Some believe that the principal factor in healing through compression is the squeezing together of the pulmonary tissue and the bringing of the ulcerative surfaces together, and the forcing out of the caseous material from the cavities and bronchi. When such results are obtained, there is a lessening of absorption and consequently a decrease of toxemia. Inasmuch as a decrease in toxemia relieves the central nerve cells of irritation, and in this way favors a general improvement in cellular metabolism, this action cannot be underestimated as a cause of improvement. We must not forget, however, that anything that aids the compressed lung must have an opposite effect upon the non-treated lung.

I would like to call attention in this connection to certain principles which are pertinent to this discussion.

Most discussions proceed as though the condition in the thorax is the same under all circumstances. This is not true. In early advancing necrotic tuberculosis, we have most of the pulmonary tissue, outside of the area of involvement, influenced but slightly. The process, as a rule, is acute, and of short duration, and little or no destruction of tissue has had time to take place; consequently, there is little or no compensatory emphysema affecting other portions of the pulmonary tissue. In case of a more extensive inflammatory condition where a loss of tissue, followed by contraction, has occurred, we have a compensatory emphysema present. •Likewise in old chronic fibroid lungs, where there is more or less displacement of tissue and contraction, we have some degree of emphysema. The compensatory emphysema which takes place in tuberculosis must be looked upon, as I have discussed in Vol. I, page 493, as an attempt on the part of nature to preserve the equilibrium between the atmospheric pressure on the outside of the chest wall and that within the thorax, as it is connected through the trachea and nares. It is not an hypertrophy from overuse; it is a part of nature's attempt to fill up the space which has previously been occupied by pulmonary tissue.

When artificial pneumothorax is established, we do not, necessarily, obtain a high degree of emphysema in the other lung because that portion of the thoracic cavity, which was previously occupied by pulmonary tissue, is now filled by gas; consequently the equilibrium between the outside and inside air pressure is maintained. If the compression is of a sufficient amount to use up the entire reserve lung area, and encroach upon the amount of pulmonary tissue, which is absolutely essential to carrying on oxygenation, then an increase in respiratory effort results. If the amount of compression is short of this no dyspnea is induced. There is one factor, however, that must be considered. When artificial pneumothorax is employed the soft tissues are the ones that are compressed first; consequently, the normal tissue is collapsed prior to the diseased tissue. Particularly is this shown where much fibrosis exists. In acute caseous pneumonia the softened masses might be compressed almost as easily as the normal tissue in some instances. Thus, in order to obtain a favorable result, firm compression is essential. The chest must, if the patient will stand it, be filled full. I do not mean that this must occur at once; but I do mean that in order to be successful the diseased areas must be compressed. In those cases where we are dealing with an old chronic process with fibrosis, success will be hampered unless we can totally compress the lung. This has been the experience of all who have been using this method. If we produce a complete compression on one side we must expect that the non-compressed lung will be forced to do more work than normal and the effect of this must be carefully watched if the non-compressed lung is the seat of active disease. Respiration will most likely be increased at least upon exertion; and the blood which formerly circulated through both lungs is now compelled to be oxygenated by one. It is very fortunate that nature has endowed man with more lung capacity than he needs to carry on the functions of life; because he can stand a considerable decrease without discomfort or harm resulting. Could we know our cases accurately, and have a thorough conception of the pathology within the chest, pneumothorax might be used much more advantageously than it is; but our diagnostic methods have not so far, given us a degree of accuracy which makes us feel assurance on this point.

A patient breathing sixteen times a minute for twenty-four hours would breathe nearly twenty thousand times per day. If, by artificial pneumothorax we use up reserve lung area, respiratory effort must necessarily be increased. So, if our theory that rest is the essential for the cure of the lesion, is true, then we would fully expect the lesion in the other lung to be increased in activity by the extra work that is thrown upon it.

This question should be discussed in relationship to the question of why the apex of the lung is infected more easily than other portions of the pulmonary tissue. In my discussion of the predisposing factors to tuberculosis, I called attention to the fact which every observing clinician must know,—that tuberculosis in adults rarely begins at the base of the lungs; and, further, that tuberculosis in all degrees of pathological changes is found much less frequently in the lower portion of the lungs. I explained this as being due to the compressing of the apices and the resultant narrowing of the lymph spaces and lessening of the blood and lymph flow at the apices as compared with other portions of the lungs. I have noticed that when a high degree of compensatory emphysema occurs in a lung, there is greater motion in that lung; and that this portion does not seem to be as liable to infection as other areas of lung tissue. I am under the impression that the reason for this is that implantation through the blood stream, or through the lymph channels is not so readily attained. Anything that hastens the circulation, either of lymph or blood, and particularly if, at the same time, it decreases the spread of infection from previous foci, would have a tendency to lessen the danger of new infection occurring. To be sure increased respiratory effort would favor bronchogenic infection; but, when the most active process is compressed this danger is somewhat removed.

The two greatest factors in the death of tuberculous patients are the extension of the disease to new tissue and the toxemia from existing foci. If artificial pneumothorax will bring about such conditions as will prevent the former and relieve the latter then it must be a meritorious measure.

One of the serious factors in healing tuberculosis after loss of tissue and cavity formation has occurred is the fact that the cavity must heal while open. Conditions are present which prevent its compression and the bringing of the sides into apposition. Pulmonary compression when successfully applied, favors this.

Fishberg[4] clearly states the remedial effects of artificial pneumothorax as follows:

"Inflating gas into the pleural cavity and collapsing the lung we achieve two objects. The lung is immobilized at its root, and is compressed by gas in the pleural cavity and the retraction of its elastic tissues. Its volume is greatly reduced, diseased parts and walls of cavities are brought into apposition, so that they may cicatrize by the formation of connective tissue.

"Pneumothorax does even more than afford rest to the diseased lung. By compression it empties the lung of its contents. The pus and cheesy detritus in cavities, the inflammatory exudates in the alveoli and bronchioles are all squeezed out as from a sponge, removing the main source of toxic absorption. It also limits the diseased focus and prevents its spread, so that the healthy parts of the lung remain so while the lesion is in time converted into a cicatrix, or is encapsulated. As a result of drainage, mixed infection is eliminated and prevented. The fact that the air current entering through the trachea cannot circulate within the collapsed lung tissues, prevents superinfection of healthy parts of the organ with emboli of detritus carried from one part to another along the bronchial tree and mixed infection with microorganisms other than tubercle bacilli, which may be brought in with the air current is avoided.

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[4] Pulmonary Tuberculosis, Lea and Febiger, Philadelphia, 1916.

"The circulation of the blood is impeded in the collapsed lung, but there occurs a venous or passive hyperemia which is known as an important factor in the defense of tissues against tubercle bacilli. The comparative protection against tuberculosis enjoyed by cardiacs is ascribed to the venous hyperemia of the lungs. The lymph channels of the collapsed lung are compressed, as has been shown by Shigu,[5] who subjected animals with induced pneumothorax to the inhalation of soot, and at the autopsy found that the collapsed lung remained free from soot. Animals were compelled to inhale large quantities of soot, and subsequently pneumothorax was induced, and when they were finally killed, it was found that the free lung was darker than the collapsed lung. This tends to show that the circulation of lymph, which is the main factor in removing inhaled particles from the lung, is impeded or arrested because of stasis in the compressed lung. In this manner the absorption of toxins from the lesions into the general circulation, is impeded or arrested in pneumothorax, the clinical phenomena of phthisis, such as fever, night sweats, weakness, etc., are prevented, and the body is thus given an opportunity to recuperate. Moreover the lymph stream, being unable to carry away bacilli from the lesion, the process is localized to the affected areas. Those points have been found clinically and at the autopsy table, and experimentally by Forlanini,[6] Brauer,[7] Saugman, Graetz,[8] Robinson and Floyd,[9] Hamman and Sloan,[10] G. M. Balboni,[11] Henry Schwatt, Ralph C. Matson, A. G. Shortle, and many others."

Technic.—Artificial pneumothorax is performed by injecting gas into the pleural cavity. Formerly nitrogen was used exclusively because it was thought that nitrogen did not absorb so quickly as air; but, more recently, atmospheric air has been found to answer every purpose.

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[5] Beiträge zur Klinik der Tuberkulose, 1908, Bd. xi, s. 1.

[6] Ergebn. d. inner, Med. u. Kinderheilkunde, 1912, Bd. ix, s. 621.

[7] Beiträge zur Klinik der Tuberkulose, 1909, Bd. xii, s. 49; Bd. xiv, s. 419; 1911, Bd. xix, s. 1.

[8] Beiträge zur Klinik der Tuberkulose, 1908, Bd. x, s. 249.

[9] Archives of Internal Medicine, 1912, vol. ix. p. 452.

[10] Johns Hopkins Hospital Bulletin, 1913, vol. xxiv, p. 264.

[11] Boston Medical and Surgical Journal, 1914, vol. clxxi, pp. 697 and 955.

Forlanini and Murphy made a puncture through the skin and superficial tissues by a needle, and injected gas in this way. Brauer and Spengler consider that, owing to the difficulties which one meets, it is better to cut down to the pleura before introducing the needle. This method, however, has not proved to be as popular as the puncture method. Patients object to incisions being made every few days over a prolonged period of time in order to carry out this treatment; and those who are conversant with artificial pneumothorax, do not feel that they are essential.

Apparatus for the administration of artificial pneumothorax may be simple or complex. It is necessary to have two graduated bottles, connected by a tube, one containing the gas to be injected and the other some fluid. When the gas is to be injected the fluid is allowed to flow into the bottle containing the gas so as to displace it and force it into the pleural cavity. The tube connected with the bottle containing the gas is T-shaped, or provided with a three-way stopcock, connecting with the bottle, the manometer, and the needle. It is necessary to have this so arranged that the tube going to the manometer and the one going to the gas bottle can be connected or disconnected at any time.

The use of the manometer must be fully understood by those who wish to employ artificial pneumothorax. Normally, intrapulmonary pressure is negative; consequently, when a needle passes into the pleural cavity, the air is sucked into the cavity and the fluid in the manometer is sucked toward the needle and each respiratory effort is recorded by oscillations of the fluid in the tubes.

Choice of Site of Puncture.—It is a principle in performing artificial pneumothorax to make the puncture over healthy lung tissue if possible, thus avoiding pleural adhesions which are so commonly found; consequently, if it is the apex which we are particularly anxious to compress, it is well to make the puncture low down. Either anterior or posterior axillary line is usually chosen. The lower spaces are best,—the ninth being commonly used. If it is the base of the lung that is to be compressed the puncture is usually made over the anterior upper portion of the chest, the third interspace near the anterior axillary fold being the common place for puncture. The skin should be thoroughly disinfected and cleansed. The point of puncture should be painted over with iodine, and then a few drops of cocaine or novocain, either with or without adrenin (1 to 2000) should be injected not only through the superficial tissues but deep down in the pleura. It is thought that the cocainization of the pleura guards against pleural shock. At times, on account of adhesions, it is difficult to puncture the pleura, and one may have to change the point of puncture many times; in fact, some observers have tried in a dozen or more places without success. The fluoroscope, when available, may be used as a guide to the place of puncture, but ordinary methods of physical examination are usually sufficient. The free movement of the edges of the lungs has been utilized as indicating that adhesions are absent when free movement occurs. I would like to call attention to the effect of pleural thickening in producing an inflammatory condition and a degeneration of the subcutaneous tissue covering the thorax. This I have discussed in many places in these pages. I am sure if this were appreciated it would be a great aid in helping one to avoid pleural adhesions. For those who are interested, I would like to call attention to the pathology which I have quoted from Coplin in Volume II, Chapter XXV. The superficial tissues over chronic pleural adhesions are atrophied and show in a loss of substance and a doughy, inelastic feeling to the palpating finger.

Artificial pneumothorax is not a measure to be put in the hands of those who are not careful. It requires a knowledge of tuberculosis, diagnostic acumen, and surgical judgment to carry it out effectively.

Amount of Gas to be Injected.—Observers differ greatly as to the amount of gas to be used on first inflation. Some believe in gradual inflation; in fact, more men are leaning toward this than formerly. A very common method is to inject first 200 or 300 c.c., then repeat the injection every two or three days, putting in a like amount until the desired degree of compression has been attained. Others inject 1000 to 2000, or even 3000 c.c. at a time. It seems to me that there can be no definite rule. The more gradual method appeals to me as being safer; at the same time, if one knows his patient thoroughly, and is conversant with conditions present, the probabilities are that the result could be hastened at times by varying the amount of gas injected according to conditions to be met. One should always bear in mind that the effect of compression is to cut off pulmonary tissue and also pulmonary circulation. So large a quantity should not be used as to embarrass either the circulation or respiration.

For physiological reasons the patient should be required to rest for a while after pulmonary compression. Many observers do not observe this rule and claim that they have seen no ill effects following exercise, even within a few minutes after the pleura has been filled; but one conversant with the physiology of the circulation and respiration must be convinced that the patient should be under most favorable circumstances while such a degree of compensation as is made necessary by the compression is taking place. The amount of compensation varies according to the amount of pulmonary tissue compressed, but any patient secures this equilibrium more quickly under rest than under exercise. The amount of gas to be injected should depend somewhat on the character of the process and the amount of destruction in the lung.

The amount of gas finally used will depend upon the degree of compression which it is desirable to obtain. Where many adhesions are present, one may be able to inject only small quantities, though larger amounts are desirable. Under such circumstances the results will be correspondingly disappointing. If one cannot compress the necrotic lung and the secreting cavities, favorable results must not be expected.

Length of Treatment.—When artificial pneumothorax was first brought out it was thought that this would be a quick cure for tuberculosis; but it has proved to be no more rapid than other well established methods. Saugmann[12] says that the usual cases must have refills during a period extending over three or four years. It is not necessary, however, to refill these chronic cases as frequently as it is the more acute ones; consequently, he permits them to go about their work and have a refilling every two or three months. Refilling is not as difficult as the first injection because some air is already in the pleura, and the same difficulty of entering the pleura is not met unless conditions have existed which have favored the parietal and visceral pleura becoming adherent.

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[12] Zur technik des künstlichen Pneumothorax, Beiträge zur Klinik der Tuberkulose, 1914, Bd. xxxi.

The Difference in Symptoms Presented During Artificial and Spontaneous Pneumothorax.—Artificial pneumothorax is, as a rule, accompanied by a decrease of toxemia. If the patient has been previously toxic, this toxemia will be decreased in proportion to the success attained in compressing the toxic areas. The patient notices very little discomfort if the amount of gas introduced is at first small. If it is large he may suffer from dyspnea and rapid heart. Sometimes, too, if adhesions are stretched, considerable pain is experienced. Spontaneous pneumothorax, on the other hand, is, as a rule, accompanied by certain definite signs, as has been described in Chapter XXVI, and as is illustrated by Case 1828, page 609. The most common symptoms that I have found in spontaneous pneumothorax are sudden rapid heart and rise of temperature. The dyspnea, or feeling of compression, varies according to the amount of air which enters the pleura and the compression which results. They also vary according to the rapidity with which the pleural sac fills. If it fills rapidly, the symptoms are usually more marked than if it fills slowly. There is often a benumbing effect upon the patient's sensibilities. In numerous instances I have seen a slight delirium present. If the pneumothorax is on the side where there is much softening, we may have a marked decrease in expectoration because of the compression of the cavities, and the checking of secretion. On the other hand, if it throws an extra burden upon the other areas which are secreting, we may have an increased amount of expectoration because of the pus which is forced out from the ulcerating cavities. The probable difference in symptoms between artificial and spontaneous pneumothorax depends largely at least, upon the amount of gas which is introduced, and the rapidity with which the pleura is filled. Why the temperature should rise so commonly in spontaneous pneumothorax I am unable to say. The after effects of spontaneous pneumothorax are often just as marked as those from artificial pneumothorax. If the spontaneous pneumothorax is due to rupture of a tuberculous focus which has been producing a considerable degree of toxemia, its rupture is often followed by a decrease of such toxemia and a drop in the temperature and pulse. If, on the other hand, there are other areas involved, which are not relieved, temperature continues.

Complications.—Artificial pneumothorax is not without danger. One of the most common dangers is that of *pleural shock.* This complication is not well understood, although many observers have met it in practice. The symptoms are those of increased pulse rate, dyspnea, and pallor, which may last a few minutes, or may last quite a while. The patient also, at times, manifests considerable anxiety. In a few instances death has resulted from it.

Pleural Effusion.—Pleural effusion is one of the very common complications of artificial pneumothorax. Saugmann's statistics[13] of this complication are exceedingly interesting, and show that while the greatest per cent of cases occur during the early months, some cases will occur even as late as three and a half years. The following table shows the occurrence according to the period of treatment:

In the course of	1 month	2	patients
“ “ “ “	2 months	5	“
“ “ “ “	3 “	14	“
“ “ “ “	4 “	3	“
“ “ “ “	5 “	6	“
“ “ “ “	6 “	3	“
“ “ “ “	7 “	6	“
“ “ “ “	9 “	2	“
“ “ “ “	10 “	1	“
“ “ “ “	12 “	2	“
“ “ “ “	12-18 “	3	“
“ “ “ “	18-24 “	1	“
“ “ “ “	30-36 “	1	“
“ “ “ “	36-40 “	1	“
		50	“

In summarizing his results he says that 50 of 96 patients showed pleural exudate; but, inasmuch as three of these patients had pneumothorax done on both sides, he considers it as though there were 99 instances of pneumothorax. Of these 21, or 21 per cent, showed the exudate within the first three months; 33, or 33 per cent, within the first six months; 41, or 41 per cent, within the first nine months; 44, or 44 per cent, within the first year and 50, or 50 per cent, within the first three years.

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[13] Brauer's Beiträge zur Klinik der Tuberkulose, 1914, Bd. xxxi.

There has been considerable discussion as to whether or not pleural exudate does harm. It is the general opinion of many of the best observers that it interferes with the treatment and that those who do not have exudate obtain much better results than those who do. This rarely takes upon itself the form of true empyema. Of course, this would occur in case it became infected with other microorganisms. It does, however, even in the experience of the best observers, now and then take upon itself a creamy consistency, which is characteristic of a tuberculous condition. This rarely absorbs, although, at times, it organizes and forms fibrous tissue. This I have also seen occur in patients who had suffered from spontaneous pneumothorax. A patient who is under my care at the present time, had quite a large amount of creamy pus in his right pleura a few months ago, which has now become organized and transformed into scar tissue.

There has been considerable speculation as to why a pleural exudate should occur. Some consider that it is due to the irritation of the gas; others that it is produced by a tuberculous process on the surface of the pulmonary pleura, which would result in adhesions if the pleural surfaces were in apposition; but which results in exudation, now that they are separated. It seems to me that a factor of considerable importance is the natural function of the pleura. The pleura naturally produces a slight amount of fluid. Experiments show that the parietal pleura has the greatest absorptive power. As long as the two surfaces of the pleura are in apposition, unless fluid is produced very rapidly it is absorbed and carried off, but now, that they are separated, there is no doubt but that the absorptive mechanism is interfered with, and this might easily be sufficient to account for the accumulation.

Lighting Up of Activity in the Non-compressed Lung.—This is an accident which often follows pulmonary compression. Some writers report such effects noticed in 3 or 4 per cent; others in a smaller per cent. A question of this kind is exceedingly difficult to determine. The amount of activity started up in a non-compressed lung can only be determined after a period of considerable observation. Many of these cases of tuberculosis are given one or two, or half a dozen compressions and pass from view. The after-history of such cases is not known. We do know, however, that it is an accident that will happen every now and then. We must also bear in mind that every case of renewed activity occurring in the non-compressed lung must not be ascribed to a pneumothorax any more than it should be ascribed to any other plan of treatment, because it is the natural tendency, particularly in the advanced cases, for the disease to disseminate, and for quiescent foci to take upon themselves activity.

Injury to Lung Tissue.—This has occurred in numbers of instances, the effect of which may either be serious or not, according to the point of injury and the amount of damage done. It may occur when gas is put in under too great pressure, resulting in tearing adhesions or in rupture of a cavity wall. In several cases cavity walls have been ruptured in this way. In other instances, the needle has been pushed into the pulmonary tissue, piercing the small air channels—allowing a spontaneous pneumothorax to result.

Gas Embolism.—This is another danger. When introducing the needle it may enter a blood vessel, and if air is allowed to escape, it may be carried to any portion of the body. If it finally is carried to the coronary artery or the cerebral vessels it may prove fatal. This may be almost wholly eliminated by the careful use of the manometer. If one will be sure that the needle is in the free pleura before injecting the gas there is little danger of this accident occurring. It is an accident, however, which might happen to anyone.

Emphysema of the Superficial Structures.—This also occurs occasionally. This seems to be more common where the Brauer method is used than where simple puncture is employed; at the same time, it may happen under both circumstances. It is not serious. The gas escapes through the puncture in the pleural wall and finds its way into the superficial tissues producing a peculiar puffiness which disappears after a short time.

Indications for Artificial Pneumothorax.—This question cannot be discussed in the abstract. Whether a patient should be treated by artificial pneumothorax or not depends very much upon what treatment he would receive if artificial pneumothorax were not administered. So much can be accomplished in these days by faithfully applying such measures as open air, rest, exercise, food, psychotherapy, tuberculin, hydrotherapy, heliotherapy; and by relieving distressing symptoms and looking carefully after the patient's comfort, that there remains only a very small number of patients unsuccessfully treated, in whom it is possible to secure a satisfactory result. In this connection we must remember, however, that there is no specific remedy for the disease, and that results are achieved only by employing enough helpful measures to raise the patient's fighting strength to the desired level. Pneumothorax is not a cure for tuberculosis, but offers aid under certain conditions, which may otherwise be attended by failure. If the diagnosis is made sufficiently early and other approved methods of treatment are intelligently applied, pneumothorax will rarely be found necessary.

Some would recommend pneumothorax in all cases of tuberculosis, even those of the early clinical type, but he who takes this attitude wholly misunderstands tuberculosis; totally underrates the efficacy of present methods; and greatly magnifies the importance of, and minimizes the danger of artificial pneumothorax. If pulmonary compression were a "cure" for tuberculosis, then such a course would be logical; but it is not. It is only a makeshift. It is only another measure to be employed as an aid in certain cases pending the finding of some specific remedy. It must be prescribed with such an understanding if it is to do its full measure of good, and not be abused. There is one type of case which appeals to me as being particularly adapted to artificial pneumothorax treatment,—that is the type of unilateral acute advancing ulcerative tuberculosis, which fails to yield to ordinary measures. Most of the unfavorable results which are reported in the treatment of tuberculosis, by any method, are due to insufficient time being employed in treatment. Tuberculosis is a slow going disease.

Healing takes place very slowly. We cannot give an opinion upon the curability of tuberculosis unless we treat our early cases over a period of six or eight months, or a year; our moderately advanced cases from eight or ten months to a year or more; and the far advanced cases from one to two years or more,—sometimes even four or five years; consequently, most men who discuss the curability of tuberculosis are discussing it without having had adequate experience. They have not carried on their efforts long enough to prove whether or not the patient could have eventually obtained a favorable result.

Artificial pneumothorax is often urgently recommended in the treatment of hemorrhage, particularly in recurrent attacks of bleeding, where a few mouthfuls are expectorated day after day. Those cases which result from an open vessel of any size as a rule, prove fatal before a pneumothorax could be performed. Other types of pulmonary hemorrhage nearly always stop of their own accord, if the patient is given but half a chance. If he is treated by rest and sedatives, particularly when necessary in order to check coughing, nature will nearly always take care of the lesion herself,—in spite of what is being done for the patient.

Result of Treatment.—The induction of pneumothorax must not be looked upon as being a simple and harmless procedure. In my study of the pathology of tuberculosis, I have been led to have great respect for the heart. The heart bears the brunt of tuberculosis. Most patients who have suffered from advanced tuberculosis die of the disease by a heart death. The burden of forcing the blood through the contracted pulmonary area sooner or later tells upon the right heart and shows in dilatation. In acute pneumonia where one half of the pulmonary area is involved, a marked strain is thrown upon the heart, which often proves fatal. In chronic tuberculosis we do not notice this strain so readily because it comes on gradually and the patient adapts himself to the change. In the former instance acute toxemia is a factor, while in the latter chronic toxemia is present. The strain is there just the same and it comes when the heart is much weakened, however, because of prolonged toxic action which has interfered more or less with its nutrition; consequently, the compression of a great portion of the lung,—and, in order to obtain results in these advanced cases, complete compression is desirable, and often essential,—throws upon a weakened organ a strain which has a detrimental effect upon it.

CHAPTER XLV.

TREATMENT OF SYMPTOMS.

Cough.—Cough is one of the most constant symptoms of advanced tuberculosis. As a rule it makes its appearance early and lasts throughout the course of the disease.

Cause of Cough.—Cough is due to irritation of the vagus nerve. It may result from many different conditions, such as inflammation in the pulmonary tissue itself; secretions in the bronchi; irritation of the pleura; traction upon the larger branches of the nerve such as occurs when marked contraction of one of the upper lobes takes place; irritation, either tuberculous or non-tuberculous, in the larynx; and inflammation and catarrhal conditions of the pharynx.

In the early stages of the disease cough due to secretion in the bronchi is not very pronounced; but, later, after the ulcerative and destructive stage has been reached, large quantities of secretion are produced and more cough is required for its expulsion. Probably the most distressing and severest form of cough in tuberculosis is that which occurs in a chronic contracting lung. In a chronic fibroid lung during the stage of contraction, the cough, being due to traction upon the nerve, cannot be relieved by the expulsion of mucus. Patients with this type suffer from severe paroxysms of coughing which, unless relieved, continue at times until a stage of exhaustion has been attained. Bad habits of living and overexertion have a tendency to increase cough. Extra exertion calls for more oxygen and this throws more work upon the lung. As the pulmonary tissue is compelled to do more work, the tendency to cough is increased; consequently, rest is one of our most important factors in the treatment of cough.

Conditions of the weather have a great influence upon cough. Sometimes cold, chilly mornings will produce considerable increased cough,—doubtless largely through stimulation of the cutaneous nerves. Damp and foggy weather also increases it. One reason why more cough attends damp than dry weather is because a patient has more mucus to expectorate during damp than during dry weather. Air returns from the lung saturated with moisture; consequently, dry air will carry off a great deal of moisture and in this way relieve the patient from cough, and the effort made necessary by expectoration. This is one of the favorable influences exerted by dry climates. On the other hand, at times we see patients whose cough is increased by the irritation caused by extremely dry air. Extremely dry air will irritate some mucous membranes prior to the time that they have become accustomed to it.

Much of the cough in tuberculosis can be avoided if the patient understands that it is not necessary to yield to every impulse. There is a general belief that all mucus in the air passages should be coughed up; consequently patients permit themselves to cough at the least irritation in the larynx. Nervousness greatly increases the amount of cough. The patient should be instructed so that he understands that all unnecessary cough should be avoided. Cough is sometimes followed by vomiting. This is particularly true during the acute stage of softening. The vagus at this time is irritated to an unusual degree; and with the tendency to cough, the patient is usually forced to vomit.

The relationship of the upper air passages to cough requires emphasis. Most all patients in advanced tuberculosis have more or less catarrhal condition of the nasopharynx and larynx. These local disturbances produce a great deal of unnecessary irritation which results in coughing.

Effects of Cough.—Cough produces injurious effects in several different ways. By its explosive action it injures the tender fibrils of new tissue which are thrown out during the process of healing. This interferes greatly with healing, and at the same time, causes a greater amount of fibrosis to result than would otherwise be necessary. While we are anxious to produce an abundance of fibrous tissue in order to encapsulate the bacilli which remain viable in the lung, at the same time we desire to prevent a too extensive formation. When cough is present for a long time it causes dilatation of air vesicles, resulting often in an undue amount of emphysematous tissue which interferes with the oxygenation of the blood. As a result of continuous coughing, an injurious influence is exerted upon the abdominal viscera.

Cough retards the flow of venous blood toward the heart, thus causing stagnation in the venous system throughout the body, particularly in the splanchnic vessels.

Most of the common routes of metastases in open tuberculosis are through the bronchi. Bronchogenic infection is favored as cough has a tendency to force the mucus into the bronchus, plugging the opening. This implantation is often followed by metastases throughout a greater or lesser part of the lung area supplied by that bronchus.

In the treatment of tuberculosis rest is a very important factor. Exercise calls for extra blood, extra oxygen, and increased metabolism. We enjoin rest from walking and exercising the arms, but we forget that those muscles which are brought into action during the act of coughing are performing work the same as the muscles of the arms or legs when brought into use. There is no doubt but that patients who have severe paroxysms of cough more or less continuously during the day, perform exercise equivalent to a walk of a mile or even more; consequently, when we are thinking of rest for the patient, we should think of the rest from coughing as well as from walking and exercise carried on by the arms. It is not uncommon to see a rise in temperature of two or three degrees follow a severe paroxysm of cough. Cough is oftentimes followed by vomiting, as mentioned above; and, when this occurs, it may interfere seriously with nutrition, if the condition persists long.

Treatment of Cough.—Treatment must at times be directed to every part of the respiratory tract, according to the part that is particularly influencing the cough. Rest in the open air, general hygienic living, and proper training, are the big factors in its relief.

The remedies which are most effective in its control belong to the opium group. Heroin 1/16 to 1/6 is very effective, probably the most effective remedy that we have. Codeine, while less active, at the same time is a very important remedy. It may be used in doses of 1/8 to 1/4 grain. Both of these must be repeated until the desired effect is obtained. In some patients smaller doses than these may be used to advantage. Morphine and Dover's powder are at times effective, when other conditions requiring their use are present.

Such remedies as creosote, eucalyptus oil, chloroform, menthol, and carbolic acid may be used advantageously at times in the form of inhalations. Inhalations of compound tincture of benzoin are particularly valuable during acute bronchitis.

If creosote does not disagree with the patient, it may be administered internally in doses of 10 drops after meals, and will sometimes be of aid.

Cough is sometimes caused by the taking of food. Particularly is this true when the vagus nerve is very irritable. Under such conditions the entrance of food into the stomach is sufficient to stimulate the sensory filaments of the vagus and produce cough. This, at times, is so severe that it results in vomiting and marked disturbance in nutrition. I have usually found codeine, or heroin, given a short time before eating, to be most valuable in these cases. Sometimes, for a temporary measure, small doses of cocaine may be given, although it is a remedy that should be used guardedly.

When cough is due to a laryngeal irritation, washing the larynx with an alkaline spray followed by stimulating applications of protargol 10 per cent or argyrol 10 to 25 per cent, will usually give relief. Throat lozenges containing menthol, oil of eucalyptus, and other soothing ingredients, are of some value. Sometimes all that is necessary to stop a tickling cough is something which will give momentary relief. If the patient can resist the desire to cough for a moment, it will disappear.

Coughing results, as mentioned above, from stimulation of the vagus. When the vagus is stimulated not only is there a motor reflex, but a secretory reflex as well, consequently cough results in increased secretion. It is sometimes surprising to see how much secretion will be expelled during a paroxysm of coughing.

When the cough is due to irritation of the larynx itself we must not forget the cold compress. Cold compresses put on the throat will oftentimes relieve a great deal of unnecessary cough when due to local causes. I have not infrequently wrapped the patient's chest in a wet jacket and covered this over with flannel and bound it on tightly. This measure has proved, in most instances, to be very effectual in reducing the amount of cough.

For the upper air passages, a spray made according to some such formula as the following may be used:

Acid carbol	1.0—2.0
Sod. biborat.	0.5
Sod. bicarb.	0.5
Glycerin	10.0
Aq. dest. q.s. ad.	200.0

M.

Sig.: Use as a spray several times a day.

With this the throat and nose may be sprayed several times a day. Where a slightly stimulating spray is desired it may be made according to the following formula:

℞ Iodin resublim	0.065— 0.20
Menthol	2.00— 4.00
Camphor	2.00— 4.00
Albolene q.s. ad.	90.00—90.00

M.

Sig.: Use as a spray several times a day.

The compounding of this prescription requires some care, otherwise the iodine will precipitate. The iodine should first be rubbed with the camphor in a mortar. The menthol should then he added; and, later the albolene.

Night or Sleep Sweats.—Night sweats occur commonly in tuberculosis. They are found in other diseases, however, and consequently, are not pathognomonic of tuberculosis. These may be so slight as to produce a slight moistening of the skin, or they may be so severe as to wet the clothing and bedding. The explanation of the night or sleep sweats is not wholly clear; although I think we are able to offer a better explanation than formerly. The explanation of this will come through a more intelligent understanding of the vegetative nervous system. There is some question whether the sweats are due to stimulation of the sympathetics or the parasympathetics, as mentioned elsewhere in these pages. We know that sweating is, at times, a part of the syndrome of toxemia. It rarely comes on prior to or during the rise in temperature, during the stage of vasoconstriction which is now and then accompanied by feelings of chilliness:

but while the temperature is declining. It follows the passing off of the fever for the day, consequently accompanies vasodilatation.

Sweating occurs as a result of severe toxemia when there is a condition of vasodilatation approaching paralysis. Pharmacologically, sweats belong to the group of phenomena caused by parasympathetic instead of sympathetic stimulation because they are controlled by atropin. Atropin counteracts the action of the former and produces the same action as stimulation of the sympathetics. We find our physiologists unable to settle the question of their causation. It might be that the action of atropin in the control of sweating is an exception to the general rule that atropin depresses the parasympathetics; or it might be that both parasympathetics and sympathetics have a part in sweat production. Whatever be the actual explanation, we know that when the toxic curve for the day as represented by the degree of temperature is on the decline, sweating occurs.

In early tuberculosis, an amount of toxemia which produces a fraction of a degree of temperature is often sufficient to cause sweating. Our most severe sweating, however, accompanies severe toxemia and comes when the patient is suffering from active tuberculosis, at a time when the inflammation is acute and accompanied by rapid softening of tissue. Under these conditions, the equilibrium of the vasomotor system is seriously interfered with, and when vasodilatation starts following the diurnal decline of toxemia, as illustrated by the temperature curve, sweating becomes very profuse. Sweating in some of these cases is almost as severe as it is in acute toxemia, accompanied by collapse.

We must not lose sight of the fact that sweating is a characteristic of some individuals. Thus, patients who are decidedly of the vagotonic type will now and then be drenched with perspiration upon the least excitement. This would look as though sweating is a part of vagus stimulation; but, inasmuch as it is a part of the general syndrome of toxemia, which is due to sympathetic stimulation, we are unable to classify it etiologically. All patients who have tuberculosis and perspire are not necessarily suffering from so-called night sweats of tuberculosis. Sometimes sweating is due to warm weather or to the fact that the patient uses too much cover and at other times it is due to the general low physical and nervous state of the patient.

Treatment of Night Sweats.—An important factor in preventing night sweats is to relieve the patient of all possible factors which lower tone and favor sweating. To this end the depressive emotional states which produce sympathetic stimulation should be corrected. While it is impossible to stop a toxic condition due to absorption from an active necrotic process in the lung, there are toxemias due to other causes such as intestinal stasis which may be relieved. Their relief may be sufficient to establish the degree of improvement in nerve tone necessary to prevent sweating; consequently, when we put the patient at rest in the open air, where his appetite will be stimulated, and relieve him of pain, worry, discontent, fear, and other toxemias that may be depressing him, we may be able to prevent sweats. The effect of the open air life is often very marked in stopping slight or even severe sweats. This it does by improving the nutritional tone of the skin and bringing about a more healthful stimulation of its nerve endings. Hydrotherapeutic measures are valuable because of their tonic effect on the skin. The morning cold sponge has much to do with the checking of night sweats; so do sun and air baths.

If sweating persists, in spite of the usual hygienic measures, I often have the patient rubbed with a solution of equal parts of vinegar and water immediately before retiring. Sometimes plain cool water itself will suffice. The effect of such measures is undoubtedly due to their local tonic effect. If the patient is suffering from an advanced lesion with softening, the sweats may persist in spite of these simple measures. They should be persisted in, however, and be made a part of treatment, no matter whether they give complete relief, or not. Atropin is one of our most reliable remedies when the preceding measures fail. It should be administered at night in doses ranging from $^1/_{100}$ to $^1/_{60}$ grain. As a rule, hygienic measures alone or in combination with atropin, will usually control the sweats if they can be controlled.

There is a popular idea, and this is shared by many physicians, that night sweats are weakening. This is another illustration of taking the cause for effect. Slight sweating as noted in early tuberculosis is not accompanied by much weakness. The fact that the patient's strength is low during severe sweats is because of the toxemia from which the patient is suffering. Toxemia reduces general vitality. It interferes with metabolic activities and causes a disturbance in elimination and in this way interferes with the activity of the entire organism. Night sweats are sometimes very annoying because of the tendency of the patient to chill following them. The patient will go to sleep and wake up covered with perspiration. Sometimes the clothing will be so wet that chilling is almost sure to follow. Where patients have a tendency to perspire freely I advise them to take a bath towel to bed with them, and, if they awaken drenched with perspiration, wipe themselves off thoroughly before they change their night clothing.

Severe night sweats are most evident in patients who are not properly cared for. During the past few years I have seen very few cases of distressing sweats. The modern intelligent methods of caring for patients, keeping them under hygienic conditions, improving the condition of their skin and enhancing their general metabolism, prevents much of this sweating; and where it is unable to accomplish this, it relieves most of the distressing effects.

Fever.—I have discussed the subject of fever at length in Chapter XXX. It is so important to understand this subject that I have endeavored to give as accurate a picture as possible of it and its various types met in tuberculosis. I will not discuss the subject extensively now, but desire to emphasize the fact that fever is not an entity. Fever in infection is an integral part of the syndrome of toxemia. While there is an increased metabolism present which gives an increase in the production of heat during the active stage of tuberculosis, yet this would quickly adjust itself, if heat elimination were not interfered with. About 15 per cent of heat is eliminated through respiratory activity, and about 80 per cent is given off by the vessels of the skin; consequently, the most important factor in heat retention is increased vasoconstriction of the vessels of the skin. This is present as a part of the stimulation of the sympathetics as a result of toxemia.

The effects of fever and toxemia have been heretofore confused. Writers have been ascribing to fever what should be ascribed to toxemia in general. Fever does not produce digestive disturbances, aching, malaise, and rapid heart's action; but toxemia does. So, fever must be looked upon simply as a visible effect of toxemia. It is something tangible hence its importance has been magnified.

Fever itself probably has some beneficial influences. Many observers have shown by animal experimentation that increased temperature of the body causes the body cells to produce an increased number of specific proteolytic enzymes. Increased body temperature also changes the medium upon which bacteria are growing and in this way reduces their activity. It is a common experience that a rise in the temperature of the incubator, checks bacterial growth. The same thing most probably occurs in the body; consequently the rise in temperature during infection probably checks the activity of bacterial growth and produces changes which are favorable to the increased reactivity of the body cells, resulting in increased specific protective substances.

Treatment of Fever.—From this discussion it can be seen that we must not direct our attention too much to fever. We must in every way possible endeavor to reduce the activity of the microorganisms. We must raise the patient's resisting power; we must reduce the amount of poison that his body is required to destroy in a given time. This we can do to a limited extent by rest. Toxemia is always undesirable, so we should do all in our power to relieve it as quickly as possible. Unfortunately, in tuberculosis, do what we will, there is no direct way of checking toxemia when necrosis and absorption have occurred. We must endeavor to conserve the patient's strength, however, and carry him through until the necrotic areas have been eliminated and the absorption of toxins has ceased. There are toxins from other causes, such as the gastrointestinal tract, also from other foci of infection, which may be relieved. There are also other factors which produce sympathetic stimulation and have the same effect as toxemia upon the system, such as pain, fear, anxiety, and discontent. Relief from these will greatly aid the patient in fighting his toxemia.

Increased temperature does not always mean increased toxemia. It sometimes means an interference with the elimination of the heat which results from normal physiological action. We must not think that every time exercise increases a person's temperature that it increases his toxemia; nor that when he coughs and increases his temperature thereby that this necessarily means increased toxemia; nor that the rise in temperature which follows nervousness is an increased toxemia. I think these conditions have been misinterpreted. To be sure, exercise, whether it be produced by walking or coughing, or whether it be due to such passive exercise as massage, is oftentimes followed by an increased amount of toxins being thrown into the circulation to stimulate the nerve centers and produce increased toxic effects; but, an increase in temperature resulting from increased metabolic activity, and an increase due to faulty heat elimination may exist aside from an increase in toxemia. Temperature may also be reduced without reducing toxemia.

Rest in bed is essential to the treatment of patients suffering from toxemia. It prevents them from expending unnecessary strength and keeps the temperature from going unnecessarily high. The effect of placing the patient with fever in the open air, especially if he has been living with inadequate ventilation, is often marked. There needs be no fear on the part of the physician, or others, in placing the patient in the open air, providing the patient's resisting power is such that he can adapt himself to the weather conditions. It would be foolish to expose a patient with low vitality to the severe rigors of the open during a northern winter. He would probably be better off in a protected room where the air movement could be controlled and where the stimulation from the cold would make less requirements upon his powers of reaction than in the open air. Since we now know that it is not an increase in oxygen that is wanted, nor an increase in CO_2 that we are attempting to escape, we can understand the foolhardiness of exposing a tuberculous patient to atmospheric conditions which call upon his body for greater reactive powers than it possesses. Common sense must rule even in the application of open air. There is a tendency to use open air regardless of the patient, and to place weak, toxic patients out into the open, regardless of weather conditions. I do not wish to be understood as opposing open air for the tuberculous. This I believe in firmly; but I believe in applying it with judgment, based on the physiological action of the remedy.

Lest I be misunderstood, I wish to emphasize that in my opinion, open air should always be utilized in the treatment of tuberculosis whether of febrile or non-febrile type, when the degree of cold and stimulation is not too great for the patient's reactive powers. When the open air makes demands upon the patient's reactive powers, which cannot be satisfied, then greater good will result to the patient by permitting him to remain in a well ventilated room.

Not only open air, but air baths, which may be given by allowing the patient to lie naked, or covered only with light covering, make the patient comfortable in warm seasons and warm climates and stimulate his reacting powers. Patients with fever should usually be covered with as little clothing as will afford comfort. Sometimes they may have fever and still be chilly. Such patients will have to be covered well, and not only covered well, but may require artificial heat such as that afforded by hot water bottles in order to prevent them from chilling. Sometimes sponging of the patient will relieve his temperature and make him more comfortable. Tepid water is better for this purpose than cold water. It is the evaporation of the water from the surface carrying off the body heat that gives the relief from the temperature.

Normally an individual begins to sweat when the body temperature increases one or two degrees. In this way he eliminates heat rapidly. In fever due to toxemia, however, sweating is prevented by the vasoconstriction which results from the toxic action and so this method of eliminating heat is withheld from the patient. Not until the natural diurnal decrease in heat production occurs does vasodilatation with sweating take place. Sponging takes the place of sweating to some extent and helps the patient to throw off heat by evaporation.

It is rarely necessary to resort to pharmaceutical remedies for the relief of fever, although now and then, not only may temperature be reduced, but the general symptoms of malaise and aching, may be relieved at the same time by small doses of such remedies as phenacetin, aspirin, or various combinations of acetanilid.

Pain.—*Cause.*—Patients suffering from tuberculosis have more or less pain throughout the course of the disease. Reflex sensory pains are extremely common. These are reflex from the inflammatory process in the lung and express themselves on the surface of the body through the sensory nerves, which take their origin in the segments of the cord which receive afferent impulses from the inflamed areas in the lung.

There are certain zones pointed out by Head and confirmed by clinical experience, in which this type of pain is very common. These areas are in the third and fourth cervical zones, which are found over the shoulders and the neck; also the third to fifth thoracic zones. These are found particularly about the third and fourth interspaces anteriorly and the scapular region posteriorly. There is considerable pain through these areas during the course of tuberculosis. Neuritis affecting the motor nerves is also common. The nerves which furnish motor, as well as sensory impulses, and which take their origin from the segments of the cord which are stimulated by afferent impulses from the lung, are thrown into a state of continuous excitation, as long as activity persists in the pulmonary tissue. As a result of this, the nerve cells become irritable and the nerves themselves show pathological change. The nerves which show this most markedly are the upper intercostals and certain cervical nerves. Irritation of the cervical nerves often shows as pain in the shoulder muscles, and also as aching through the interscapular region throughout the muscles supplied by the upper thoracic nerves. Patients often complain of rheumatism of the shoulder in the presence of old chronic tuberculosis. Instead of being rheumatism this is a neuritis. These pains are influenced by many different things, particularly by changes in the weather and toxemia. Toxemia of any type is apt to be followed by pain in these affected nerves.

Another form of neuritis which is exceedingly common in tuberculosis, is that which comes from the nerve being involved in an inflammatory process. Such a type is extremely common in cases of thickened pleura, where the tissues of the chest wall undergo pathological degeneration. The nerve partakes of this inflammation, becomes irritable and expresses this irritability in pain. This type has been described by Coplin in Chapter XXV. This also probably accounts for some of the pain that is found in the upper intercostal nerves. More or less inflammation and thickening of the pleura takes place when the underlying apex is the seat of tuberculosis. The inflammation passes through to the intercostal nerves and in this way produces its effect. Aside from these common pains which affect the tuberculous patient, he is subject to the same pains as other individuals.

Treatment of Pain.—For the relief of such pains as are induced by toxemia the patient should be treated with rest; and all other toxemias such as may be produced by intestinal stasis, infected teeth or tonsils should be relieved as much as possible. Those due to inflammation of the nerve are relieved by heat, either dry heat or moist heat. Heat may be applied in the form of a hot water bottle, electric pads, or a drop light, in which the globe is covered with a funnel-shaped reflector. This is convenient and simple and can be found in most all modern homes. Sometimes, when pain is severe, blisters may be resorted to, or iodine may be painted over the surface. As a rule, however, heat will give as much relief as any other factor. Acute pleurisy may be relieved by strapping the chest. Heat is also of value in this type of pain. Sometimes, when the pain of pleurisy becomes very acute, some of the opiates may be used. They are especially indicated in pleurisy because of the fact that there is usually some accompanying cough, which increases the amount of pain. Codeine, heroin, or morphine itself in $^{1}/_{8}$ grain, or larger doses, if necessary; or Dover's powder in 2 to 5 grain doses every few hours, may at times be necessary. Sometimes, however, these pains may be greatly relieved without resorting to morphine, by such remedies as aspirin, phenacetin, or some of the acetanilid compounds. The latter, however, must be used cautiously because of their depressant action upon the heart. The necessity of relieving pain is evident from the effect which it exerts upon the body generally. It is not only the fact that the pain is unpleasant and difficult to bear, but pain produces harmful stimulation of the higher brain centers and exerts influences through the sympathetic nervous system which result in general inhibition of function on the part of the organs supplied by this system. The effect of pain is the same as that of such emotional states as fear, anxiety, and discouragement.

Insomnia.—Insomnia is a common symptom in tuberculosis. It is found throughout the course of the disease. Sometimes it is exceedingly troublesome and causes the patient a great deal of worry and annoyance. Sleep is important because during it, nature has the best opportunity of restoring the body waste.

There is considerable discussion among modern writers as to the amount of sleep required. Some authors take the view that all persons should have an average of from seven to eight hours sleep each night. Others claim that it is not necessary for all persons to have the same amount of sleep, and that three or four hours are sufficient for individuals of a certain type. Be this as it may, it is exceedingly disappointing to a patient who is endeavoring to overcome tuberculosis, to be unable to sleep. After one is in bed for quite a time prolonged rest seems to take the place of sleep to a certain extent. I have seen many patients who were unable to sleep more than five or six hours a night who made satisfactory recovery in spite of the fact that they could not sleep as much as they thought they should. It is well, however, to see that each patient obtains a satisfactory amount of sleep.

Insomnia may be due to many different things. The depressive emotional states such as fear, discontent, and worry, are important factors in preventing sleep. At times, patients are worrying about little things and are unable to free their minds from them. At bed time when everything is quiet and the patient is alone, it is very difficult for him to control his thoughts. They naturally run to troubles, real or imaginary, which may be bothering the patient. Sometimes the condition in the stomach is important. Patients who suffer from hyperacidity are often inclined to be restless and sleepless. Such may be relieved by a glass of hot milk, or a cracker, or other food. There is another type of insomnia which is due to the fact that the patient eats immediately prior to going to bed, or that he eats too large a meal in the evening. This type of insomnia may often be relieved by eating a light supper. Patients who are inclined to insomnia should not take stimulants with the evening meal. Oftentimes, tea or coffee taken at luncheon will still exert its influence and interfere with sleep.

The man who understands hydrotherapy often induces sleep by the use of cold compresses put snugly over the abdomen. Psychotherapeutic measures are also of value. A patient sometimes gets in such a frame of mind that he is positive that he will not sleep. He expects to lie awake and roll around in bed. He gets to the place where he pities himself. Under such conditions it is difficult to induce sleep. If such a patient can obtain confidence in his ability to sleep, this of itself will often do more good than any other measure. In this way we account for the fact that a spell of insomnia may be broken by a sleeping powder, given one night, or two or three nights in succession. The patient obtains sleep, and this shows him that he can sleep; so he expects to do so when he retires.

A pernicious habit which fosters insomnia is that of reading when one goes to bed; or, if unable to sleep during the night, getting a book and reading. The sleep habit should be cultivated, the same as any other habit. When the time comes to go to bed, the patient should go to bed, with the absolute assurance that he will go to sleep. Another habit is that of rehearsing all of one's ills and worries and trying to settle the problems of life before going to sleep. All such things should be eliminated and the patient should cultivate the habit and power of going to sleep. Now and then it will be necessary to resort to certain sleep producing drugs. There are numerous ones on the market, and it will be necessary to change from one to another in patients who have severe insomnia. The smallest dose that will produce sleep should be relied upon. It is unwise to continually give large doses of hypnotics, because they are, for the most part, followed by some depression. It is far better for the patient to learn to control his mind than to be drugged to sleep.

Trional, 7½ to 20 or 30 grains; sulphonal in the same sized dose; veranol, 5 to 10 grains, or chloral-amyd, 30 grains, may be used. The action of some of these hypnotics is greatly improved by taking them along with a hot drink. This is particularly true of trional.

Sometimes insomnia is produced by cough. Under such conditions, small doses of heroin or codeine may be added to the sleeping powder, or the opiate itself may be sufficient to bring about sleep. Where pain is an important factor in the production of insomnia, some form of opium must often be resorted to.

CHAPTER XLVI.

USEFUL PHARMACOPEIAL REMEDIES IN THE TREATMENT OF TUBERCULOSIS AND ITS SYMPTOMS.

The Value of Medicinal Preparations in Tuberculosis.—The rapid progress which has been made in scientific medicine during recent years has thrown doubt on many ideas which up to that time had been considered as established. This spirit of doubt has affected no field of medicine as markedly as the field of therapeutics. Therapeutic nihilism had gradually taken hold upon the medical profession and brought them to the ridiculous position of feeling that their highest services to mankind was in making a diagnosis. In no field of medicine has this been more apparent, and in no field has it been capable of doing more harm, than in the therapeutics of tuberculosis.

Practically every remedy in the pharmacopeia has been suggested at one time or another, as having value in the treatment of tuberculosis. This very fact is evidence of a desire to find a remedy, but a further acknowledgment that the remedies so far adopted are unsatisfactory. After the tubercle bacillus was discovered, showing the nature of tuberculosis; and after the attempt had been made to find a specific remedy for its cure, which resulted in the production of tuberculin; and after this remedy had failed in the hands of the profession, a wave of pessimism came over the spirits of all of those who had earnestly hoped that a cure might be found.

Today we must admit that there is no remedy which may be called a specific for the treatment of tuberculosis. I say this in spite of the fact that all preparations made from the tubercle bacillus have a specific action in the treatment of tuberculosis, and in spite of the fact that I am an ardent friend and constant user of tuberculin. We must distinguish between a specific, and a remedy having specific action. A specific for tuberculosis would be a remedy which would overcome the tubercle bacillus and cure the disease. A remedy with specific action, on the other hand, is a remedy which exerts its action upon the tubercle bacillus and tuberculous tissue. This, tuberculin does. When one admits that there is no specific remedy for tuberculosis he does not admit that we have no method of bringing about a healing of tuberculosis. The members of the profession do tuberculous patients a rank injustice when, on making a diagnosis of tuberculosis, they tell them that there is nothing they can do for them,—they must take fresh air, good food, and work out their own cure. *If there is any disease in the domain of medicine that requires close observation and continuous treatment it is tuberculosis.* There are many measures as I have shown elsewhere in these pages, which may be advantageously used in the treatment of tuberculosis. There are likewise many pharmacopeial remedies which afford relief to this and that symptom, and to that extent exert curative action.

In order to make clear the value of medicinal measures we must go back to the principles of cure. In discussing the principles which underlie therapy, I have endeavored to make clear that there is no remedy like salvarsan and mercury in syphilis, antitoxin in diphtheria, and quinine in malaria, which has the right to claim the distinction of being a specific. All that we can do is increase the patient's resisting powers, either by remedies which act generally, or by those which relieve harmful symptoms and complications, and thus indirectly improve metabolism; or stimulate the formation of fibrous tissue about the foci of infection by using remedies which, being made from the tubercle bacillus, have a specific stimulating effect on the body cells and are capable of producing a focal reaction. Any remedy, or measure, whether it be of a pharmacopeial, physical, or physiological nature, aids to the extent that it will improve the general metabolic activity of the patient, or stimulate the focus to the formation of scar tissue.

With this definition it can readily be seen that pharmacopeial measures have a part in the therapy of tuberculosis. A remedy which will relieve cough, night sweats or insomnia, likewise one which will correct a gastrointestinal disturbance, or relieve pain, will aid in the cure of tuberculosis to the extent that relief from these symptoms and complications is able to raise the resisting power of the patient. Oftentimes, it is only by affording relief in a number of little things that we are able to start our patient on the road to recovery. A pharmacopeial measure which will relieve these conditions deserves as much credit as other measures. The better one understands tuberculosis and the tuberculous patient, and the closer the association between the physician and the patient, and the greater the confidence the patient has in his adviser, the fewer pharmacopeial measures will be required. Different men will put varying degrees of confidence in different remedies. One may rely on drugs, another on rest, while still others will emphasize food and open air; but all are working toward the same end. *It is not so much which individual remedy is pushed to the greatest extent, but the result depends on whether or not enough remedies are brought to bear in the individual case to improve the patient's metabolism, and raise his resisting power sufficiently high to overcome the disease.*

It should be definitely understood, however, that the medicinal treatment of tuberculosis is only an aid, and that it should be considered only as an adjunct to other general measures such as open air, exercise, hydrotherapy, and psychotherapy.

Remedies Which Have General Action.—Out of the many remedies which have been used in tuberculosis there are a few which have been used extensively by sufficiently competent observers to indicate that they have merit. The fact that we do not know just how the improvement is brought about by them is not a sufficient reason for denying that they aid cure.

Creosote.—This is a remedy which has been used more than any other and which still has many devotees, in spite of the fact that most men have discarded it. Personally, I have never been convinced that creosote has any specific action upon the tuberculous process itself, although many men claim this. Neither have I been impressed with its value sufficiently to cause me to use it routinely. There are certain times, however, when creosote does seem to have value. Creosote, when given in small doses seems to have an effect in improving digestion in a certain percentage of cases. It is also well known that there is a certain percentage of cases that cannot take creosote without gastric disturbance. Creosote is supposed to have a certain deterrent action upon the development of bacteria in the gastrointestinal tract. Some writers have even claimed that the antibacillary action of creosote is so great that it might even have a tendency to prevent the implantation of bacilli in the intestinal wall, and in this way guard the patient against intestinal infection. This, however, does not seem probable. Other writers have felt that creosote exerts some definite action upon cellular activity in general. Their opinion is, that, being absorbed, it has a specific action upon the body cells. Still others feel that it has a direct action upon the tuberculous tissue in the lung; and administer it for that purpose. Creosote is eliminated through the bronchial mucous membrane. It seems that some favorable local influence is exerted upon the cells in the bronchi in cases of inflammation of the bronchial mucous membrane. That creosote is capable of greatly influencing bronchial secretion, particularly heavy purulent sputum from cavities, seems unlikely.

When administered in tuberculosis it may be given in many different ways. Some observers confine their administration to small doses, using even a fraction of a drop several times a day. Others use large doses, pushing the remedy to the point of tolerance. In the old creosote days, patients were at times given sixty drops of creosote twice a day. Carbonate of creosote and thiocol have been especially recommended in pneumonia. I have used creosote, guaiacol carbonate, and thiocol in cases of acute respiratory infections complicating tuberculosis with apparent benefit. Where cough is marked, I commonly give inhalations of creosote. A common method of using it is represented in the following formula:

℞ Creosote	
Oil of Eucalyptus	
Chloroform āā. ad.	60.0

M.

Sig.: One teaspoonful to a half pint of boiling water to be inhaled through a funnel several times a day.

The amount of chloroform may be varied according to the degree of cough. Each of these preparations is soothing and oftentimes relieves a distressing cough. Similar inhalations are useful for fetid bronchitis and cases of lung abscess where the odor is very disagreeable.

Arsenic.—Arsenic has been used for generations in the treatment of tuberculosis. It was revived a few years ago by Landerer, who used it in the form of hetol (succinimate of soda). Arsenic had, up to Landerer's time, been used more particularly for its general tonic and alterative effect, but he claimed that hetol had a special action upon the tubercle itself. He claimed that it caused a gathering of leucocytes about the tubercle, and that this leucocytosis was a marked factor in healing. While other observers have not been as enthusiastic in their belief in the effect and action of arsenic, yet these observations of Landerer have given a new impetus to the use of arsenic as a general measure in the treatment of tuberculosis. Aside from any such effect as described by Landerer, arsenic is used for its general tonic effect and the favorable influence which it exerts upon the blood. Arsenic is used a great deal today in the form of sodium cacodylate. It may be used in doses varying from 1 to 3 or 4 grains given hypodermically, and repeated every two or three days. Arsenic may also be given in the form of Fowler's solution. From 3 to 10 drops of this preparation may be given after meals. It may be employed over a prolonged period of time in moderate doses, or it may be used to its physiological effect and then omitted to be resumed after a short rest.

Iodine.—Much light is thrown upon the therapeutic action of iodine by the recent work of Jobling and Petersen.[1] After reviewing the claims of various writers as to the action of iodine upon general metabolism in causing fall of blood pressure; in changing the viscosity of the blood; in producing a lymphocytosis; in increasing the activity of the lymphatics; and in increasing oxidation through the action of nascent iodine; they show experimentally, and offer as an explanation, that the value of iodine in such diseases as tuberculosis and syphilis depends upon its influence upon the ferment inhibiting action of serum. I quote as follows:

"The demonstration that the antitryptic action of the blood and of tuberculous caseous matter is due to the presence of unsaturated fatty acids suggested to us the possibility that the action of iodine in the body may be due to a combination with the fatty acids, thus causing a neutralization of the activity of these substances as ferment-inhibiting agents. If this supposition proved true, the neutralization of the activity of these agents should lower the antienzyme strength of the blood tissues in general and permit the removal of dead tissues by autolysis.''

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[1] The Therapeutic Action of Iodine, Archives of Internal Medicine, vol. xv, No. 2, February, 1915.

Their experience demonstrates that iodine administered to human beings causes a very material reduction in the antitryptic activity of the blood.

To quote further:

''In our work on the antiferments contained in tubercle bacilli and in tuberculous caseous material, we found that the enzyme inhibiting action was due to the unsaturated fatty acid radicals of the lipoids.'' When iodides are taken into the tissues a portion of the iodine is liberated and combines with the unsaturated carbon atoms of the fatty acids. As soon as this occurs in necrotic tissue to a degree sufficient to lower or remove the antiferment action, autolysis ensues, as in most instances, ferments are present. That inorganic iodides diffuse readily throughout caseous matter and are thus in a position to furnish the iodine has been shown by Loeb and Michaud, and Wells and Hedenberg.''

The opinion of different observers as to the use of iodine in tuberculosis has always been at variance. Some recommend iodine in the treatment of tuberculosis and urge its use in practically all cases, whether active or quiescent. Others have a great fear of the remedy and believe that it is contraindicated in all cases where activity exists.

On account of its effect upon the tuberculous tissue it is often given as an aid to diagnosis. In cases of suspected tuberculosis, with little or no sputum, iodide of potassium is given and the secretion which is caused by its administration is examined for bacilli. This is readily explained by the fact that it permits of an increased ferment action which breaks down the necrotic tissue and liberates the bacilli (Jobling and Petersen).

Iodine seems to have some advantage in fibroid tuberculosis. It exerts a favorable influence in chronic tuberculosis accompanied by asthma. It often seems to be of value in patients with old chronic tuberculosis, complicated by subacute or chronic bronchitis. Some writers—noticeably Carl Spengler, have urged its use in cases complicated by chronic or latent syphilis. Iodine may be administered in the form of iodide of sodium or potassium, or in tincture of iodine, 3 to 20 or more drops being given in milk after meals; in the form of syrup of hydriodic acid ½ to 1 teaspoonful in water after meals; or in the form of iodipin, which may be used hypodermically. We commonly use the following formula:

℞	Iodipin 25 per cent	50.0
	Menthol	10.0
	Ol. eucalyptus	20.0
	Ol. amygdal	
	qs. ad	100.0

M.

Sig.: From ½ to 1 c.c. administered every one to three days hypodermatically.

Hypophosphites were originally strongly recommended by Churchill. They have enjoyed an excellent reputation in the treatment of tuberculosis for many years. Just how they act is not known, but they are supposed to exert a favorable influence upon metabolism. They may be used either in liquid or in tablet form.

Cod Liver Oil.—One of the oldest and best established remedies for the treatment of tuberculosis is cod liver oil. It is not difficult to secure an argument on the relative value of this remedy. Whether its sole action is that of a fat, or whether there is some other action exerted by other constituents of the remedy, such as iodine, is not definitely settled. Cod liver oil is a form of fat which can be readily assimilated; consequently it often exerts a beneficial influence in furnishing food to an individual at a time when it is seriously needed. When we realize that each gram of fat contains more than nine calories, it can be seen that considerable food can be added in liberal doses of cod liver oil. It is not a palatable form of taking fat. Neither is it an economical one, unless the readiness with which it is absorbed can be shown to be enough to make this fact overcome the cost of the remedy. I have usually been in the habit of telling my patients that if they will spend their money for butter, cream and bacon, they will probably have more nutrition for the same money; but there is no doubt that many patients will use cod liver oil when they will not use other forms of fat.

Iron has long been used in various forms in the treatment of tuberculosis. Many patients suffering from tuberculosis have low iron content in their blood. The necessity of furnishing an adequate oxygen-carrying blood is self-evident. Therefore one of the aims of treatment has been to keep the percentage of hemoglobin high. To this end, iron has been used. There is a tendency, however, in recent times, to supplant its use by arsenic, clinicians believing that arsenic has an equally beneficial influence on the blood, and, at the same time, a more general tonic action. With the modern hypodermic methods of using iron it is once more coming into use, either alone or in combination with arsenic. A common preparation is citrate of iron which may be combined with arsenic and used hypodermatically. This method of administration is efficacious and practically painless.

Bromides.—It might seem strange to some that I should discuss bromides among the important remedies in the treatment of tuberculosis. To the thoughtful reader of these pages, however, this will not seem strange because the influence of the nervous system is everywhere evident to the one who is studying this disease closely. Iodine may act by combining with the fatty acids, and thus setting free ferments to act upon the tuberculous tissue. Arsenic may prove beneficial to the blood. Creosote may have some action upon the bronchial mucous membrane. Cod liver oil may have an influence upon nutrition; but none of these exert a specific action in the treatment of tuberculosis; so their part in the treatment of tuberculosis is no better established than that of the bromides, which act by relieving nerve tension, and, in this way, aid metabolic activity. I would not suggest that bromide be used continuously; but there are times in the history of most patients suffering from tuberculosis, when some sedative such as bromide will give them a better appetite, improve their assimilation, help them to sleep, and thus aid them in their fight against the disease.

This is particularly advantageous in the treatment of the nervous phenomena associated with menstruation. Oftentimes large doses of bromides, varying from ½ to 1 dram, according to the individual case, will produce a state of quiet and will ward off several days of fear, discontent and worry.

Atropin.—Atropin is another remedy which can be used for so many things in the treatment of tuberculosis, that I wish to mention it in order that its usefulness may be emphasized. I place it in the same category as bromides,—not as one of the remedies which is commonly mentioned in the treatment of tuberculosis and which is supposed to have some definite and direct action, but a remedy which can aid greatly in relieving distressing symptoms; and, in this manner add its part to the therapy of this disease. The use of atropin in the control of night sweats is well known, but there are other places where it can exert a much greater influence. Wherever we have evidence of increased vagus stimulation, if this is proving harmful, atropin is indicated. Thus it finds use in hay fever; in asthma; in that type of breathing in tuberculosis which resembles asthma, and which seems to be associated with bronchial spasm, and often an increased bronchial secretion. It is also of value in hyperacidity and hypermotility, whether this takes the form of diarrhea or spastic constipation. In types of gastrointestinal trouble where there is a great deal of gas and colicky pains, atropin is the ideal remedy. These and many other conditions may be relieved by it, and the patient benefited to the extent that relief from the troublesome symptom will aid him.

CHAPTER XLVII.

HOME TREATMENT.

The Problems of Home Treatment.—While the sanatorium, if properly conducted, offers the ideal conditions for the treatment of tuberculosis, yet we must recognize the fact that most patients who are suffering from this disease are obliged to be treated in their own homes; consequently, it is necessary for physicians to familiarize themselves with the principles of treatment, and study the problems sufficiently closely to be able to surround the patient in his home with conditions as ideal as possible. To this end it is necessary to bear in mind that the condition which is often least difficult to supply is the one which is usually emphasized most—open air sleeping accommodations. The most difficult, on the other hand, and the most important, is to provide the patient with hopeful, helpful, cooperating influences. This requires a thorough training on the part of the attendants and those who must come in contact with the patient. These desiderata will be attained in a comparatively small percentage of cases. Few patients possess sufficient self-control, and the requisite degree of self-denial to carry out a protracted regime amidst the distracting influences of the home; and few friends possess the judgment to associate with patients who are attempting to carry out such a regime, and afford them the moral support which is needed. The degree to which this aid is given depends upon the physician guiding the cases. In my experience the patient is far more tractable than the friends and relatives. Too much emphasis is laid on the open air sleeping quarters, and not enough on the surrounding influences.

The home treatment of tuberculosis will be successful in direct proportion to the manner in which sanatorium principles are established and carried out. By the term "sanatorium principles" is meant a carefully planned program of hygienic living, personal hygiene, regulated rest and exercise, food prescribed to suit the needs of the patient, and other measures which are directed toward increasing the patient's vitality, and surrounding the patient with an atmosphere of cheer and hope.

How to Arrange the Patient's Quarters in the Home.—There are two things to bear in mind in treating the patient in the home: first, the arrangement of the room, or whatever accommodations are occupied by the patient in such a manner as to afford the greatest aid to recovery; second, the training of the patient so as to avoid scattering infection and transmitting the disease to others.

The room occupied by the tuberculous patient should be arranged so as to have free access to air and sunlight. Whenever it is practicable the patient should have an open air apartment. This can be arranged in many ways, according to the house occupied and the financial condition of the family. It may be very costly and be furnished sumptuously; or, it may be simple, consisting of nothing more than a place to put a bed.

Intelligent people, seeing the necessity of outdoor life, are gradually adding sleeping porches to their dwellings; but, where a sleeping porch is not convenient and cannot be built on readily, the open porch may be used. In cities, roofs of buildings have furnished the required open air to many patients. Sometimes a tent may be put up in the yard advantageously. When this is used the floor should be above the ground so as to avoid dampness. A screened porch may be had at very little expense; and, where expense is not to be considered, very elaborate open air rooms may be constructed. Fig. 141 illustrates the Pottenger Sanatorium bungalow which has proved very satisfactory for out-of-door living. Whenever possible, the apartment occupied by a tuberculous patient should be enclosed with screens. Window tents, such as that described by Knopf, have been employed so that the patient may have his body in a warm room, while his head is out of doors.

The particular factor of importance required in the sleeping accommodations for patients is not the size of the room and the amount of air or oxygen that it contains, but the freedom with which the exchange of air can take place. From the discussion in Chapters XXXVI and XXXVII on Open Air, and Climate, it can be seen that the curative factor in open air is not the oxygen, but the physical action of air upon the surface of the body and the effect which it produces upon the entire organism in the way of relieving heat stagnation within the body. A room may be stuffy and still contain sufficient oxygen to carry on the functions of the body perfectly. It may contain a large per cent of carbon dioxide and still produce no poisonous effects; but, unless the air in the room is in motion, it fails to stimulate the metabolic activities of the patient and fails to favor the proper elimination of heat and moisture from the body.

If it is impossible for the patient to have an open air sleeping apartment, the best should be made of the accommodations at hand. To this end a room should be used, if possible, where there is cross ventilation, and the bed should be put in the path of the moving air, rather than back in the corner so as to avoid air currents. Air currents are not harmful when the patient becomes accustomed to them. Where rooms with only one window must be used and where conditions are such that cross ventilation cannot be had, I advise my patients to place their bed along side the window so that they may have as much of their body as possible exposed to the air as it enters the room.

It is essential that the physician should carefully arrange details of treatment. He must look after the placing of the bed as one of the important things in prescribing fresh air, otherwise the patient, fearing the draughts, is likely to place the bed so as to deprive himself of the benefit of the circulating air.

The next important thing in arranging the apartment for the tuberculous patient is to see that the room is plainly and simply furnished. All unnecessary trappings and hangings should be removed. It is best that no carpet be on the floor. Curtains should not hang at the windows and there should be as little furniture in the room as is consistent with comfort. The room should be so arranged as to prevent accumulations of dirt and infectious material, and so that it may be easily cleaned.

Instructing and Training the Members of the Family.—After accommodations have been supplied to the patient in such a way as to afford him the best application of the open air life possible under the circumstances, the next important problem is to furnish him with helpful surroundings. The difficulty here is that the patient is the exception. Home activities are intended for the well. It requires sacrifices not only on the part of the

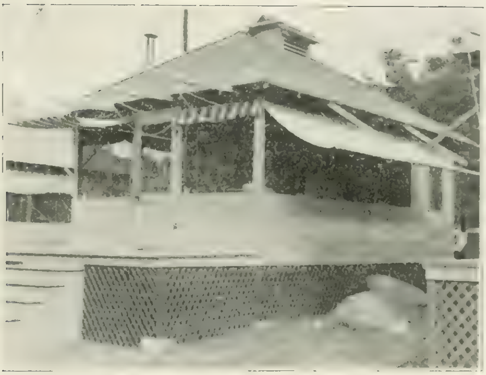

Fig. 141.—Pottenger Sanatorium bungalow.

patient, but on the part of other members of the family in order to create the proper atmosphere and to afford the necessary help to the patient. It is the duty of the physician to explain this fully to the friends and members of the family, so that they may cooperate thoroughly toward the one end, that of keeping the patient interested in his treatment, and avoiding distractions, worries, and excitements of various kinds. This is one of the hardest things to accomplish. It is far more difficult than furnishing open air sleeping apartments, and it is no less important. The whole family must have confidence in the line of treatment and must be imbued with the necessity of aiding the patient to carry it out, otherwise failure is almost sure to result.

The friends must know that tuberculosis is a chronic disease, which runs an uneven course. They must be prepared for the exacerbations of symptoms which come now and then, and must be able to encourage, rather than discourage, the patient at these times. It is necessary for the physician to tell them what their attitude toward the patient should be, and see that he obtains support and encouragement in carrying out his program. Friends must not be too solicitous. They must not nag. Nagging stirs up rebellion and destroys the spirit of cooperation. The patient must be treated as an intelligent being and must be expected to use judgment. If he does not, it is the physician who should correct him and not the attendants.

I have seen many patients driven almost to distraction by over-anxious relatives and friends. Again, I have seen them throw away their chances of cure by following the advice of relatives and friends who tried to minimize the seriousness of their disease and urged them to do things which would prove harmful. Cooperation of all parties concerned is difficult to obtain, but indispensable to the highest degree of success. Whether this shall be obtained or not, will depend largely upon the physician.

In the preparation of food for the patient care must be exercised. There is too much of a tendency on the part of solicitous mothers, wives, and others, to be too desirous of pleasing the fancies of the patient. The patient's appetite is not the proper guide to the food that he needs and should have. The friends who are around him, unless they are properly trained, have little, if any more, judgment than he; consequently it is the duty of the physician carefully to supervise the diet of the patient. To this end, I use a method which I have found very practical—that of asking the patient to write down, after his meal, each article that he has eaten, and the quantity of each. In this way I roughly keep account of what the patient is eating and am enabled to make more accurate suggestions than would be possible if I were depending on the patient's telling me off hand of what his diet consists.

The diet of the tuberculous patient should be made up of substantials. While puddings and dainties are at times tempting to the appetite, they should not be given an important place in the dietary. They contain little nutrition; and are prone to take the place of substantial food. Food should be cooked plainly and be served as attractively as possible. The diet should consist of such articles as steaks, chops, roasts, fowl, fish, eggs, potatoes, various vegetables, grains, and moderate quantities of fruits. It is not necessary to stuff the patient with milk and eggs and make this an essential part of the diet, if the patient eats sufficient albuminous food in other forms. Such things as beef tea and broths have so little nutrition in them that they can be eliminated from the diet with little loss.

I find it advantageous for the patient to eat a large breakfast. At this time the temperature is lower than at any other portion of the day, and if the patient will learn to eat a large breakfast he will be able to take care of it before his fever rises (if he has reached the stage where he is running fever), and consequently, will be able to digest it better than if it were taken at noon or at night. If the patient has no fever, this is not a bad rule, either, because it furnishes the fuel at the beginning of the day and helps the patient at the time that he needs it most. I endeavor to have all of my patients learn to take large breakfasts. I then prefer to have them take a light lunch and another heavy meal in the evening. The patient should endeavor to sacrifice little whims in diet to a sufficient quantity of substantial foods. It will be found that nearly all patients must change their habits of eating in some manner. Not infrequently this change will extend to the type of food eaten, as well as to its method of preparation.

One common abuse in the home treatment of tuberculosis is stuffing the patient. I am sorry to say that this evil is still indulged in, in some sanatoria, as well as in homes. There is no more reason for the overfeeding of tuberculous patients than there is for the overfeeding of people in general; and surely no one would advise such a procedure. Too much food is harmful, rather than beneficial, whether it stores up fat or fails to do so. The least amount of food that will preserve the physiological balance of the patient is the best amount for the patient to consume. In the home the friends are apt to base their judgment of the efficiency of treatment almost wholly upon the weight that the patient gains. They point with great pride to a fat flabby dyspneic patient, thinking that such a condition is favoring cure. A physician may permit and advise this overfeeding in self-defense because a gain in weight is expected by the family as a favorable evidence of improvement; but such a course is not justifiable. The same rule should be adopted in the home as governs in the sanatorium—no interference should be permitted; and whims and wrong notions should be corrected. The patient should be kept in good nutrition; but, above all things else, he should not be made fat.

Patients often express the idea that when they think of tuberculosis they think of fresh air, milk, and eggs. They should be taught that open air, milk and eggs, are not cures for tuberculosis, but only aids when used advantageously. Milk and eggs do not cure tuberculosis. When combined with other foods, they furnish material for replacing cellular waste and adding to the structures of the body. When used in greater abundance than can be utilized for these needs, they are either stored up as fat, or they produce digestive disturbances and harm the patient.

Training of the Patient.—The most important thing is to give the patient the correct mental attitude. He must be made intelligent. He must understand something of the nature of tuberculosis and the principles of treatment. He should know that tuberculosis is a disease that will yield to treatment, but that its cure is exceedingly difficult; and that this difficulty depends not wholly on the pathology of the disease, but partly on the inability to secure a proper cooperation on the part of the patient for a sufficient length of time to permit the tuberculous tissue to be converted into scar. He should be told that although the symptoms may all be gone, the pathological changes are still not complete and that it requires a much longer time to convert his tissue into scar and secure a permanent arrestment. So that there shall be no misunderstanding, I usually tell my patients that no matter if the physician should prescribe the best method of treatment and the patient should cooperate to his fullest extent, there is a possibility that failure might result; but that such cooperation is the thing which is most conducive to success, and it will often bring a hopeless case to a favorable termination.

A daily program should be devised. The patient should begin and end his day at definite hours. Regularity is essential to best results. In the sanatorium, if the patient has not slept he prepares for breakfast at the same time, anyway. So should it be in the home. Putting off breakfast for an hour or two and permitting the patient to sleep gives the patient the rest, but, as a rule, spoils his breakfast and probably the remaining meals of the day. A patient can adjust himself to a regular regime and, after a short time will fall into it naturally. Habit is one of the greatest factors in life and it is essential that the patient who is going to enter upon a course of treatment for a period of six or nine months or a year, should form the right habits at the outset. I tell my patients to first arrange the hours for meals so that there is about five hours between them, thus 7:00, 12:00 and 5:00, or 8:00, 1:00 and 6:00. They should awaken half an hour or so before breakfast, so as to take a sponge bath and be ready for breakfast. After breakfast they should be told what to do, which should differ according to whether the patient is wholly confined to bed or is permitted to exercise. If he is confined to bed, it is best for him to rest for a time. If he wants to look at the morning paper, or do a little reading, this is permissible. Sometimes he may be permitted to visit with his friends, but he should, as much as possible, stretch out the little things that he has to do, over the entire day rather than work intently upon any of them, or all of them, at one time. Absolute rest for a short period before luncheon should also be enjoined.

If the patient is able to be up and around he may occupy part of his time with exercise, the nature and amount of which is to be accurately prescribed by the physician. After luncheon it is best to have two hours set aside for rest. During this period the patient should sleep if possible. If not, he should learn to rest without reading and without visiting. Friends and others should leave the room and he should be left alone. Following the rest a little reading, or sewing, or whatever amusements are permitted, may be engaged in again for those who are in bed. Those who are able to be up and around may again resume their exercise. After supper I think it is best that little or no visiting be indulged in, and no outside friends be permitted to see the patient, because friends from outside the family are rarely trained and are apt to use poor judgment in their conversation, and so produce excitement and worry. While things of this nature should be prevented as much as possible, they cannot be wholly eliminated; so they must be so controlled as to produce as little harm as possible. For this reason I think the visiting permitted the patient should be confined, when practicable, to the early portion of the day. This will nearly always guarantee better rest to the patient.

The hour for retiring should not be later than nine o'clock, and, in bed-patients, even earlier. No excuse should be accepted for not retiring at the appointed time. The patient can accustom himself to going to bed at one hour as well as another. There are a few exceptions to this, but the exceptions are not nearly so common as patients would lead us to think. These supposed exceptions are usually based on a desire not to cooperate fully, rather than on absolute fact. It has been my observation that patients who are most prone to think that they cannot carry out a careful program of this kind are the ones who need it most. They are the ones who are nervous and feel that they must be doing something. The best thing for a patient of this kind is thorough relaxation and thorough rest for both mind and body. Such patients can often gain the best control of themselves by lying flat on their backs, without pillows, for two or three hours each day, as mentioned in Chapter XXXVIII.

The patient should be instructed carefully regarding the danger of infecting others. All sputum should be carefully destroyed. The manner of doing this must be left to the physician in attendance. Sometimes one method is best, sometimes another. Patients often express a dislike for the use of sputum cups. One cannot blame them; at the same time, sputum cups and cuspidors, in my estimation, are the safest way of caring for the sputum.

As long as secretions are kept moist there is no danger of the escape of bacilli with the resultant infection of surroundings. When patients expectorate in cloths and in paper napkins, no matter how careful they are, there is greater danger of scattering the infection. This is probably a little more pleasing to the esthetic sense of the patient and those around him, but it is not as safe a procedure. The covered sputum cups made of paraffin paper are convenient and efficient when facilities are present for their destruction by fire; but, unless they can be so destroyed, there is no advantage in using them. In this country, where we use gas in the homes for the greater portion of the year, patients find great difficulty in destroying their sputum boxes, as well as in burning cloths and Japanese napkins. I am not sure but what the safest method of destroying sputum, under these circumstances, is by the use of the cuspidore. This may be a floor cuspidore, or, what is better, a small vessel which may be placed on the table by the side of the bed, the same as the paraffin cups. This should contain some liquid, either water, or an antiseptic solution. My objection to antiseptic solutions is that patients are apt to place more dependence upon them than their efficacy warrants. Cleanliness is essential in tuberculosis and I think the patients are much better when they are trained to use care rather than to depend upon germicides, but, whichever is used, its efficiency depends much on its ability to keep the sputum moist until it is disposed of.

These cuspidors should be emptied into the toilet twice a day and the vessel should be cleansed with boiling water; or, what is better, they should be boiled themselves.

There has been some objection expressed to emptying bacilli in the sewer; but, the process of decomposition which takes place in the sewer will for the most part destroy the bacilli or render them inert, although not as quickly as formerly thought.

I do not think the presence of bacilli in the feces is sufficiently understood by those who come in contact with tuberculosis. We have shown, in the Pottenger Sanatorium, that large quantities of tubercle bacilli are swallowed and that the feces contain many bacilli, so the same care should be utilized here as in caring for the sputum. The patient should know that the spray from his mouth during coughing and talking is also capable of scattering infection. It seems that the only way that this danger can be avoided is by the patient learning to suppress his cough as much as possible or to cough with his mouth closed; but this is extremely difficult when cough is severe. At these times Japanese napkins may be advantageously held before the mouth and destroyed by fire before the bacilli scatter.

One will readily learn that there are a great many inconsistencies in caring for tuberculosis. One of them is the use of paper napkins and allowing the sputum to dry on them, as it will quickly do. Unless they are burned at frequent intervals, they are bound to scatter some infection. On the other hand, if the patient does not hold something before his mouth, he will scatter bacilli upon his bedding and infect his surroundings. This danger is not so great with the patient in the open air, or if he has a room which is well supplied with light, particularly sunlight; at the same time, the danger should be reduced to the minimum by care on the part of the patient.

It is the part of safety that the dishes used by the patient should be kept separate from those that are used by the rest of the family, as long as bacilli are found in the sputum. They should be boiled after each meal; or, at least be scalded with boiling water.

Towels, napkins, bedding, and linen which are disinfected by washing are not infectious. Soiled linen should be immediately disinfected.

If these precautions are taken by the patient, it is safe to rely on the light which enters the apartment, and proper cleaning of the room, to take away practically all of the danger of infecting others.

It is necessary to say a word about children. It is not best that they be in the room occupied by a tuberculous patient. This danger is particularly great in crowded houses, in damp, dark quarters, where conditions for the life of the bacillus after discharge, are favorable. The greatest contamination, however, takes place immediately surrounding the patient, and children should be especially forbidden to play on the floor of the apartment occupied by the tuberculous patient. There is no danger in the air itself, unless the bacilli have dried and infected it, but this danger of infection is exceedingly slight if ordinary precautions are taken. The child may be taken into the room with perfect safety, providing it is not allowed to play on the floor, or on the bed, and, providing the patient does not play with it.

How Often Shall the Physician Visit the Patient?—This subject is of far greater importance than is usually believed. The position of the physician is a unique one. The patient depends upon him wholly for advice and guidance. The rest of those about him, as a rule, are not trained attendants. This is true in a great percentage of cases, even where a special nurse is on the case. Special nurses, unless they have had special training and made a special study of tuberculosis, as a disease, in both its clinical and pathological aspects, are not able to guide the tuberculous patient. It requires a broader knowledge than is possessed by the average nurse safely to guide and advise a tuberculous patient when emergencies arise.

The patient should be seen as often as is necessary to produce the best results; but, as I have said elsewhere, for best results frequent visits are essential. The patient must be seen often enough to keep his interest stimulated and to give him the necessary aid for cure. In my estimation, every other day, or three times a week, is not too often to see the patient, if satisfactory results are to be expected.

CHAPTER XLVIII.

SANATORIUM TREATMENT.

Advantages of the Sanatorium.—It should be understood at the beginning of this discussion that there is nothing magical in the sanatorium, nothing about it *per se* that will cure tuberculosis; but, if properly constructed and properly managed, it offers the ideal place for the ideal treatment of tuberculosis.

Sanatoria, as a whole, may or may not be accomplishing the most that they are capable of accomplishing—the same as those who are treating tuberculosis outside of sanatoria may or may not be producing the best results that can be produced. Failures should not be taken as a criticism of the sanatorium plan of treating tuberculosis. They should rather be recognized as occurring because the idea is not properly worked out in practice. That sanatoria are especially adapted to carrying out the measures and methods which are recognized as having particular curative powers in tuberculosis cannot be denied. That conducting such institutions is attended by great difficulty is equally true. The tuberculous patient needs special care. He needs conditions which are difficult to obtain in the ordinary home. He needs these over a prolonged period of time. He can obtain them best in institutions which are properly adapted for furnishing them. That the length of time makes the treatment monotonous, and often makes the patient difficult to please and control is equally certain; but, this is a matter that depends on proper management and is not inherent in the idea itself. It is equally or even more true of the patient outside of the institution. There is no question but that the sanatorium is the place where the scientific application of such measures as air, rest and exercise, light, tuberculin, hydrotherapy, psychotherapy, and other aids may be applied most advantageously. A great advantage also accrues to the patient by having him isolated, in that he is less prone to such infectious diseases as colds, bronchitis and influenza.

The best endorsement of the sanatorium treatment really comes from the adherents of the home treatment; for, as the writer said in a former paper:[1] "The true position of the home treatment of tuberculosis, however, can readily be understood by the fact that it is an attempt to apply the sanatorium regime and sanatorium conditions to the home."

The same idea is expressed by Knopf[2] thus:

"The home treatment can be made most successful when we imitate, as far as practicable, all the salient features of aerotherapy, as produced in the sanatorium treatment. In these institutions the patients live out of doors virtually twenty-four hours of the day."

Walters[3] says:

"The modern treatment of consumption can only be properly carried out in a sanatorium, or in a place which has been converted into a kind of sanatorium. Of these alternatives the first is by far the easiest." He then quotes from Professor von Leyden[4] as follows:

"If it is asked whether treatment in sanatoria is absolutely necessary, we must admit that the same results may also be obtained elsewhere, but with greater difficulty, and only under unusually favorable circumstances * * * * The possibility of treatment outside a sanatorium with equally good results cannot be denied, but it requires much more prolonged rest and much more time on the part of the physician, and has by no means so certain a result. In any case, I regard it as a great advantage if the patient can spend once or twice a period of several weeks or months in a good sanatorium."

He further quotes from Latham,[5] who says:

"With few exceptions, patients should be sent to a sanatorium as soon as we are in a position to say positively that they are suffering from consumption. It is true that in some instances just as good results can be obtained by the patient being sent away from his friends in the charge of a physician or nurse specially trained in this form of treatment. Treatment on these lines, however, is expensive, and is seldom called for."

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[1] The Gradual Evolution of a Sane Therapy in Tuberculosis, Lancet-Clinic, March 18, 1911.

[2] Tuberculosis a Preventable and Curable Disease, Moffat, Yard & Company, 1909.

[3] The Open Air Treatment of Pulmonary Tuberculosis, Wm. Wood & Company, New York, 1909.

[4] Über den gegenwärtigen Stand der Behandlung Tuberkulöser, pp. 15-17, Berlin, 1897.

[5] Pulmonary Consumption, p. 118, London, 1905.

One of the great advantages of the institution is that things are systematized and conducted for the patient, while, in the home, everything is arranged for the well, and works against, rather than in his behalf.

Walters[6] says:

"The essence of Brehmer and Dettweiler's method is the elimination of haphazard treatment and the prescription of absolute repose or of various degrees of exercise, according to definite medical indications."

While it is possible to obtain excellent results outside of a sanatorium, as all therapeutists must admit, yet it is more difficult. It is impossible to have the same absolute control of the patient. The close feeling of personal relationship and responsibility, of mutual interest and cooperation between the patient and physician, the cheerful helpfulness which comes from the association of many who are making the same fight, enduring the same sacrifices, and struggling toward the same end, are found only in the sanatorium. The psychical effect of such an association is remarkable in its helpfulness.

In a former paper,[7] I discussed the relative merits of the sanatorium and the home as follows:

"In the sanatorium the patient is isolated. He is removed from home and business with their interests and worries. He is taken away from the influence of solicitous and meddlesome friends. He is kept away from many of the acute respiratory infections which are common among people in the ordinary walks of life. He is placed in hygienic surroundings in the open air, such as are rarely fully obtained in the home, which raise his resisting power and help him to overcome infections should he be exposed to them. He is placed in an environment which is especially adapted to his needs, along with other people who are trying to overcome the same disease; consequently he is profiting by the moral support of many others trying to accomplish the same purpose. Another great factor is the close association with the physician. In an institution the man at the head must stand responsible for practically every act of the patient's life. He must tell him what to do, he must also see that he does it. He regulates the patient's mode of living, his hours of exercise; his hours of rest. He furnishes his food and knows what and how much he is eating. He knows his mental attitude; and, in fact, learns to know the patient intimately, so that he can help him to make his fight for life in every way possible.

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[6] Ibid.

[7] Some of the Problems of Private Sanatoria for Tuberculosis as Observed During Ten Years' Experience in the Pottenger Sanatorium for Diseases of the Lungs and Throat, Boston Medical and Surgical Journal, July 23, 1914.

"Where the patient must be treated in the home, on the other hand, there are many difficulties. He is compelled to associate with people who are well, and he must, necessarily, to a greater or lesser extent, adapt himself to their environment. He is often discouraged in doing the things he should do and encouraged in doing the things he should not do. He is constantly annoyed by solicitous friends. The physician not being near where he can be consulted, the patient is advised by the neighbors and friends who see him, and he is often compelled not only to fight his disease, but his friends as well. His food cannot be so well controlled; his hours of rest and exercise are more apt to be disturbed, and his surroundings, as a rule, are less hygienic. He fails to have the help derived from an intimate association with his physician. He sees the physician in his office or when he calls, two or three times a week; at other times he is compelled to fight his own battles."

The sanatorium stands for the application of active curative measures and the production of results. Klebs[8] says: "The term 'sanatorium' (*sanare* to heal) presupposes the curability of the patient whom it is destined to receive. It is not merely a 'sanitarium' (*sanitas*—health), a health resort for the reception of the sick, no matter what their chances of cure.

"This refinement of terminology is, perhaps, somewhat artificial; but the tendency of late years has been to call sanatoria those institutions which admit for treatment only patients in the early stage of the disease not contraindicated to hospitals which are open to all classes of cases."

While sanatoria were originally intended to follow the German idea, to take only early curable cases, yet they have been forced, in America, at least, to receive large numbers of those who are advanced and many who are incurable. This, unfortunately, has greatly reduced the efficiency of the sanatorium as a curative institution. Whether it has lessened the good which it can do is another question.

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[8] Tuberculosis, D. Appleton & Company, Philadelphia, 1909.

Adverse Criticism.—During recent years there has been considerable adverse criticism of sanatoria and considerable disappointment expressed at the results obtained in them. This disappointment is partly justified and partly unjustified. It is true that sanatoria have not proved to be the great factor in the prevention of tuberculosis that was hoped. This hope, however, was expressed at a time when tuberculosis itself was little understood, and was based upon a misconception. It was thought the sanatorium would cure the early case of tuberculosis, prevent the advanced case, and limit further infection; thus proving a great economic saving to the community. This should be true; but, in practical application, the sanatorium sees only a very small per cent of tuberculous individuals; and these, for the most part, in the advanced stage of the disease; consequently the number of arrestments obtained is greatly limited; likewise the number of infections prevented. The disease goes on claiming its victims regardless of sanatoria.

It is not the sanatorium idea, however, that is at fault, but the manner in which it is applied. Its educational value is sometimes attacked on the ground that the inmates of institutions, to a certain extent, fail to follow the rules, when they return home. No one can say, however, what influence the knowledge and partial application of these hygienic principles may have in the physical betterment of the community and the general prevention of disease. Sanatorium principles have been adopted in many homes because of the example set by these institutions; and, where they have not been strictly carried out, a knowledge of them has helped to create better hygienic conditions.

The place of the sanatorium in the therapeutics of tuberculosis, and its place in the educational program cannot be successfully attacked, even though individual institutions may fall short and sanatoria, as a whole, may not do what some observers expect of them.

Some writers consider the sanatorium idea too costly for the returns given. They recognize the fact that there are certain patients who can be treated better in institutions than out, but believe, as an economic problem, the sanatorium fails to give value received. Even though this were true,—it is not the sanatorium idea that is at fault, but its application. No one is able to say that the well constructed institutions throughout our country, have not had a tremendous educational influence in disseminating the gospel of hygienic living and the gospel of the curability of tuberculosis. Aside from the positive teachings of such institutions, they stand as monuments silently teaching the principles of regulated living in the open air.

A discussion of the advantages or disadvantages of the sanatorium should be prefaced with a clear understanding of what the sanatorium offers; or, at least what it should offer in the treatment of tuberculosis. If hygienic living in the open air, under careful supervision, and hopeful surroundings, with the application of such measures as an efficient dietary, properly regulated rest and exercise, hydrotherapy, heliotherapy, tuberculin, artificial pneumothorax, psychotherapy, and other measures for the relief of symptoms, must be relied upon for the cure of tuberculosis, it can readily be seen that an institution, properly constructed and conducted for applying these measures to the best advantage, must be far superior, at least theoretically, for their application. That there are difficulties connected with the operation of institutions which, at times, completely thwart the supposed good effects of institutional treatment cannot be denied; but such failures are found in the application of any general idea.

Too much must not be expected of the sanatorium, otherwise it will fail. There are sanatoria and sanatoria, the same as there are surgeons and surgeons, or medical men and medical men. One succeeds; another fails. The successful man shows what can be done in his line when principles are properly applied. The man who fails does so because he is unable to apply the truths that are at hand.

If I were to make a criticism of sanatoria, as I have observed them, it would be that most of them are undermanned, both as to efficiency and numbers, and they are conducted upon a narrow inelastic plane. The idea that the institution *per se* is a factor of importance is wholly wrong. The institution is only an instrument for carrying out the idea of the head of the institution. Men must not be put in charge of sanatoria who are not fitted by nature and study to occupy such a position; because institutions cannot be better than the medical staff. In many instances the institution itself is relied upon to produce results, with the invariable consequence,—failure.

Sanatoria should not treat patients *en masse*. There is no place where such an opportunity for individualization can be found. The association between physician and patient in institutions gives an opportunity for an intimate knowledge of not only the disease and its complications, but the patient as an individual. It further gives an opportunity for applying therapeutic measures accurately, instead of haphazardly. Individualization, however, wherever practiced, presupposes a sufficient number of medical men to handle the cases, and a sufficiently close study to know the peculiarities of each individual. The sanatorium as it should be is not a boarding house. If it is a place where patients can go to treat themselves, it does not deserve the name; but, if it means a place where therapeutic measures are applied after careful study, under ideal conditions, it then deserves the name, and it will produce the best results that can possibly be produced in the treatment of the disease.

Men must not be put in charge of tuberculosis sanatoria simply because they happen to have tuberculosis. They must be chosen for their fitness, for their adaptability, and for their knowledge of the disease. The undermen, to be sure, may be those of limited experience who are being tried out; but, if they are of this class, their work must be supervised by those who know. It is the ideal place for intensive individualization, and the most accurate application of therapeutic measures; but such cannot be provided unless the institution is adequately manned—adequately from the standpoint of knowledge and training, and adequately from the standpoint of numbers.

The great danger to the sanatorium idea in public institutions comes from the fact that appointments to the medical staff are made because of political favoritism, rather than efficiency or special adaptability on the part of the appointee, and because of a false economy in not supplying sufficient medical men to care for the patients; and, further, in carrying out a policy of general niggardliness throughout, as shown in the care and keep of the patients.

There are many dangers to the sanatorium idea in private institutions, of which the following may be mentioned: Many institutions are established and conducted by men who are not particularly fitted, either by nature or training, to handle tuberculous individuals. There is such a great desire to obtain patients, that the rates are often so low that they cannot guarantee good service. This results in many admissions, but a general dissatisfaction. Patients go away with a feeling of hostility toward the sanatorium idea. The line of treatment is such in many institutions that it does not appeal to the intelligence of the patient. He cannot see that more is being done for him than he can do for himself. Thus, poor management, inadequate service, and unsatisfactory results, are accountable for much of the dissatisfaction in private institutions. All of this comes from a misunderstanding,—from thinking that the institution is the factor instead of the intelligent regime which should be maintained in the institution. One might as well send a patient to an office, instead of the physician who conducts the office.

Cost of Sanatorium Treatment.—Sanatoria are said to be expensive. It is true. Their building and equipment, however, are no more expensive than the building and equipment of other hospitals. We have not yet become accustomed to the idea that the tuberculous patient requires treatment. The necessity of expending money upon him is not felt as keenly as it is in the case of patients suffering from other diseases. If it is the duty of the state to attempt to cure the patient suffering from pneumonia and typhoid fever, so is it the duty of the state to attempt to treat the patient suffering from tuberculosis; and the expense necessary to bring about such a result is justifiable. I am not favorable to the great outlay that is sometimes made in the construction of institutions. A much cheaper plan could be carried out advantageously. I am, however, decidedly in favor of a much larger expenditure in furnishing an adequate staff and giving service that will make the patients satisfied until a result has been obtained. The cost of maintaining a tuberculous patient is not all expended upon and for him; but it is expended to prevent his children and other members of his family from becoming infected; and to prevent his children from becoming charges upon the state on account of the parent's prolonged illness and death. It must be remembered that aside from the illness of the patient, this disease produces insanity, pauperism, crime and orphanage and other conditions which have a tendency to increase the public expense. When an individual is cured, a train of events is checked which, if allowed to continue, would lead not only to his death, but to other individuals becoming dependent. This must be considered by municipalities and governments in dealing with this problem, as set forth above.

Suppose it does cost $1.50 per day for a period of six or eight months, to bring health to a wage earner suffering from early tuberculosis? What is the result? By the expenditure of from $270.00 to $360.00, an individual has been rendered able to carry on his life's work and support his family. He has been put in a class where he is not a danger to the community; his family is in a position to be supported, consequently conditions which lead to crime, pauperism, insanity and orphanage are prevented.

More Sanatoria Needed.—While today all classes of tuberculous patients are inadequately provided for, yet the class most neglected is that class of artisans, clerks, office girls and those others on small salaries who do not wish to be considered charity patients and yet who are not able to finance a long course of treatment in a strictly private institution. The day may come when there will be sufficient institutions to care for all tuberculous patients, although the fact that it is a chronic disease makes it extremely difficult to educate ourselves to the idea of its necessity. We are apt to think that it is cheaper to allow this disease to go on, than it is to provide adequate therapy for the patients during the period when they are curable. We recognize the fact that the incipient patient does not want to go to a sanatorium; in fact, he does not want to undergo treatment; but that is nothing against the sanatorium idea, or the idea of the therapeutics of this disease. It is a psychological fact that we must contend with. Until we have educated the public to the fact that adequate treatment of the early clinical case of tuberculosis will afford an opportunity for healing in a large per cent of instances, and that when this favorable result may be obtained the patient's general constitution has not been undermined, we must not expect a willingness upon the part of patients to submit to a careful regime, requiring months of submission to restriction and guidance, even though we, as medical men, know that their health depends upon it.

Supposed Disadvantages Prove to be Advantages.—There is a great deal of misinformation and wrong impressions concerning the sanatorium. It is not only the tuberculous patient that dislikes discipline and institutional life. It is distasteful to many people, but there is one thing that a patient suffering from a chronic disease like tuberculosis must learn, that is, that his whims must not be made necessities. It is essential to submit to a carefully regulated life, correcting the errors made in the past, and following the rules of hygienic living, which are essential to obtaining health and retaining it when once gained.

The fear that some patients have that they may be stigmatized as being "tuberculous" is not an argument against the sanatorium, but shows the presence of phthisiophobia, one of the worst things that we have to contend with in the propaganda for the prevention of tuberculosis. Intelligence must displace such wrong ideas. I would rather be stigmatized as "tuberculous" and regain my health and live out my life, than not to be so stigmatized and receive my palm and crown prematurely.

An institution for the treatment of tuberculosis can be so constructed and managed that nearly all of the things which are supposed to be disadvantages are eliminated. It is the common experience of patients after entering a well conducted institution, that they are surprised at the general air of hopefulness and helpfulness and the lack of depressing influences which are present. My patients often say: "I find it so much easier to get well in the institution than at home. Here everybody helps. There everybody interferes."

Walters,[9] in comparing the relative value of home and sanatorium treatment, says:

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[9] The Open Air Treatment of Pulmonary Tuberculosis, William Wood & Company, New York, 1909.

"The ordinary conditions of life in an average household are not calculated to help the consumptive to recover. Many things are done there as a matter of course which are bad for him, while other things which would be useful are as carefully avoided. A large room is supposed to supply enough fresh air for a number of people without any windows being open. If it rains the window is shut to save the furniture; if it is cold, the window is shut, with the idea of preventing the patient from catching cold. Most of the feverish patients who enter a sanatorium are found to have been walking about freely before admission, spite their fever. Night air is regarded with distrust in an ordinary household; the use of broom and duster in the patient's quarters is considered to be harmless.

"Apart from actual hygienic and medical mistakes, it is disturbing to the consumptive to be in the midst of the worries, distractions, and excitements of an ordinary household. He needs a quiet, restful atmosphere, free from the injudicious fussing of anxious relatives. He is apt to be at one time depressed about himself, at another too venturesome, and will find it a great comfort to be able to rely on the advice of a doctor who knows the treatment.

"What, then, are the supposed drawbacks to treatment in a sanatorium? They may be summed up in the statements that a sanatorium is depressing, dangerous, or expensive. It is commonly said that those who go to a sanatorium for treatment must be very miserable, because they are supposed to be a community of sick people ruled with a rod of iron. But the consumptive who is put under proper conditions from an early stage does not look ill, and only exceptionally feels ill. It is the so-called 'healthy' visitor who looks ill at a sanatorium, compared with the patients, because the latter lead a more healthy life, and very quickly respond to it. This is no exaggeration, but a familiar experience at every properly conducted sanatorium. Moreover, although the patient for his own good is debarred from certain pleasures, trouble is taken to substitute every pastime or amusement which, under the circumstances, is medically free from objection, and for those who are but little affected by the disease there are a fair number of such games and occupations to choose from. Certain essentials have, of course, to be insisted on: a warm, stuffy room is tabooed; so are highly exciting games or entertainments, and all forms of exertion which cause shortness of breath, over-fatigue, or feverishness. A reasonable amount of well-chosen food must be insisted on, and a regular and sufficient amount of rest or exercise, according to the patient's condition.

"To the tuberculous patient life in a sanatorium is far less dull than life in an improvised 'home sanatorium,' as many of my patients have testified who have continued open air treatment at home after leaving the sanatorium. To see other members of the household going about their business while the patient is compelled to rest, is often trying, whereas in a community where nobody 'goes to business,' but everybody is occupied in getting well, or in helping others to do so, this is not felt. To be in the midst of anxious relatives is a disadvantage to the tuberculous, who usually actually prefer, once they have settled down in a sanatorium, to see their people at intervals, rather than to have them on the spot the whole time."

Difficulties in Feeding Patients.—One of the most difficult problems in the sanatorium is feeding the patients. In the first place it must be remembered that patients who have tuberculosis, have capricious appetites. In the second place, they have been governed largely in their eating by personal whims and fads. They have learned to eat food that their mothers cook and enjoy it in the way that she prepares it. It must further be expected that, if anything is wrong, the patient is apt to be extremely critical, even though he may be getting better food and food prepared in a better manner than he has been accustomed to receive in his home. When he is not feeling well and his appetite is poor he is apt to think that it is the food that does not tempt him; and it requires tact to meet this argument. The usual objections to the food in sanatoria may be met by furnishing a good table. It is the first essential of a sanatorium that the table be supplied with good fresh food, properly prepared. It is not necessary that it should meet the whimsical requirements of each patient. Such is impossible. The patient's definition of proper food is the food that he is accustomed to eat, prepared in the way that he likes it. The correct definition of proper food is that which meets the physiological requirements of the body, prepared in a way to make it wholesome, digestible, and inviting. The patient should know that faults which are commonly attributed to the food supplied, are just as likely to come from conditions within the patient as from the food itself. He must be led to understand that his disease is such that his appetite cannot be depended upon. It is an adequate dietary that is desired,—not the particular food that the patient wishes. An institution is not run for the purpose of catering to whims in diet. Whims do not cure tuberculosis; but good meats, vegetables, grains, eggs, and milk, furnished the patient in sufficient amounts and well prepared, are the essentials of a proper dietary. It is not necessary that the tuberculous patients should be furnished food *en masse* in sanatoria. Individualization can be practiced there the same as in the home. In my institution most patients are on supervised diets and half of them on special diets. It does not require much more trouble to give this special attention than it does to cook *en masse*. It requires training and determination to meet the requirements as they arise, the same as it does to meet other problems which arise in carrying out the treatment of this disease. Diet in tuberculosis is a branch of the general medical treatment.

No Danger of Infection.—Dangers in an institution are greatly magnified. There is no place where there is less danger of infection than in an institution, because hygienic rules are carefully observed; a rigid destruction of tuberculous discharges is enforced; table utensils are boiled after every using; rules which prevent the scattering of infection are observed,—not only disinfection, but adequate cleaning, which is far more important,—is carried out; light and sunlight pervade every apartment, as they do not in the home. These are the greatest factors in the destruction of bacilli and prevention of infection that we possess.

Results of Institutional Treatment.—It is often said that institutional treatment does not produce better results than home treatment. This comes from comparing individual cases. My experience, in the treatment of tuberculosis, extends over twenty years. During the past twelve years of this time I have been treating patients both in the home and in the sanatorium. It is unfair to compare the results as a whole because most of my patients who have been treated in the home have been those who have been compelled, because of financial circumstances, to remain in the home. Many of them have been obliged to continue their work during treatment; while those in the sanatorium, for the most part, have been free from financial worries, although this has not been wholly true. It is my opinion, after this observation, that the chances of patients in the same economic class in the institution are far greater than those on the outside. Not only do they have better chances of obtaining a favorable result, but they obtain it in a shorter time. It is a question in my mind whether the ultimate cost of treatment is as great for the average patient in an institution as it is on the outside. If we compare the average result obtained, and the time required in obtaining it, we will see that this is true. If better results are not obtained in a properly conducted institution than are being obtained in the home, where the same degree of individualization is carried out in both places, this fact of itself is proof that the measures which we are using are just as valuable when inadequately, as when properly applied, an absurdity which does not require an answer. It stands to reason if all of the measures that we are instituting for the treatment of tuberculosis are for the purpose of raising the patient's resisting power, their efficacy should be increased when the patient is under ideal conditions for their application; and everyone must admit that the sanatorium can be made far more ideal than the home, and that the measures can be carried out with hearty cooperation in the properly conducted institution, while opposition and interference is met to a much greater degree in home surroundings. The close observation of the patient in the institution, instead of being tiresome and causing chafing, on the contrary increases confidence and control if the physicians in charge are properly qualified for the treatment of the disease. Anyone must admit that an able physician, with a strong personality, who will look after the details of his tuberculous patient, can obtain better results for his patient in the home than he could obtain with the same patient by sending him to a poorly equipped institution where the medical service is inadequate. On the other hand, a physician with inadequate training, or lacking in interest, could secure at least an equal result, if not better, by sending his patient to even a poorly conducted institution, and could obtain a far better result by sending him to an institution conducted by men especially qualified for the treatment of this disease. The same can be said of any other line in medicine. We must remember that there is nothing about the tuberculous subject which makes him totally different from other people.

Choice of Patients for the Sanatorium.—From the discussion which has preceded it can readily be seen that the choice of patients for the sanatorium is practically the choice of patients for the treatment of tuberculosis. Any patient who can be treated for tuberculosis anywhere can be treated in an institution. There is no time when the disease is too slight for institutional treatment. Patients often express themselves as not being sick enough to go to a sanatorium and physicians often tell them that if they were in the advanced stage they would advise them to go. The folly of such statements is apparent. The result is evident to every sanatorium man. Such statements come from a misconception of the nature of tuberculosis and the purpose of sanatoria. Sanatoria should be for the cure of tuberculosis, not for the care of the incurable. The sanatorium is the place to cure early tuberculosis and restore the patient's efficiency—not a place to care for the advanced case until death removes him.

The fact that early clinical pulmonary tuberculosis is a disease which yields readily to treatment and is the most curable of all chronic maladies, should be impressed upon the minds of both laymen and medical men; and hope should be held out to those who are suffering from this disease that a healing can be obtained providing the disease is treated early and properly. This should be accompanied by a truth no less important, that advanced tuberculosis is attended by serious pathological changes which reduce the patient's vitality, render the possibility of obtaining a satisfactory result far less certain, and cripple the patient's efficiency even though such a result is obtained. One never says it is too early to treat cancer, pneumonia, typhoid fever, or syphilis. We do not hear it expressed that these patients are not sick enough to be given an opportunity to recover health. It is only right to ask the same attitude toward tuberculosis and the tuberculous patient. The curability of tuberculosis has been demonstrated. Nothing but optimism should be entertained for the treatment of early clinical cases. Sufficient evidence is at hand to convince the most sceptical; yet, in spite of this, a great number of patients who suffer from early clinical symptoms die of tuberculosis. Sufficient facts to establish the curability of tuberculosis are attainable, but they are not sufficiently impressed upon the minds of the members of the medical profession or laymen.

The scientific treatment of tuberculosis in the early clinical stage will show a mortality almost as low as the early operative treatment of appendicitis,—far lower than that of early cancer. Even where breaking down has begun, and bacilli appear in the sputum, and large areas of tissue are involved, the most successful treatment obtains a favorable result in half of the cases. Our plea is not only for the early treatment of tuberculosis, but for the early institutional treatment of tuberculosis, where an institution is available. The patient who is suitable for treatment at all is suitable for institutional treatment. The sanatorium should not be reserved for the worst cases, but should be given the opportunity of handling the most curable as well as the more difficult cases.

Time is a very important factor to be taken into consideration in computing the advantages and the cost of cure. The best treatment, instituted early, will be an economy to the patient suffering from tuberculosis. It will not only greatly increase his chances of cure; but it will produce the result in a shorter time and restore the patient to a greater degree of efficiency.

Tuberculosis, when neglected, is such a fatal disease, that those who are able to do so, should not fail to give themselves the best chances of cure, immediately the diagnosis is made. If they intend to make a fight for life they should embrace the best at the first opportunity.

It does not signifiy that patients cannot get well because they cannot go to an institution; but, if they can go to a properly conducted institution, they will find it easier to follow out the treatment, and they will be surrounded by conditions which will greatly facilitate the application of remedial measures. It is in the difficult cases that the properly conducted sanatorium shows its greatest efficacy. Many patients who cannot be handled at all successfully in the home can secure an arrestment of their trouble, when properly treated in an institution. Those who will not cooperate at home often prove to be very tractable patients in an institution. We are often told when a patient is brought to us that he is disobedient and willful and unmanageable at home. Such conduct we, however, rarely find in the sanatorium. Cooperation can be obtained far better with trained attendants than it can be when the patient is surrounded by those whose advice does not carry the weight of authority. Many patients who are making an unsuccessful fight in the home may be greatly improved and properly handled in an institution. While we also plead for the treatment of those who have advanced lesions, and are seemingly incurable, yet we must not minimize the difficulties encountered in handling them. The task is not easy; but cooperation can be obtained and will often bring a favorable result.

What Complications Contraindicate Sanatorium Treatment.—What has been said above indicates that a patient who can be treated anywhere and complications that can be treated anywhere should be treated equally well, if not more successfully, in an institution. It might be well, from the standpoint of statistics and from the standpoint of policy, for sanatoria to take only favorable cases. By so doing, they could undoubtedly make a better record in the therapy of this disease and prove to the world beyond doubt that tuberculosis is curable. There has often been a question in my mind whether this would not be the wiser course to pursue; whether such a course would not have a greater educational influence in bringing the necessary proof to the world that this disease is curable. Those who conduct institutions, however, turn aside the personal gain that would come to their reputations by making a large percentage of cures, and turn aside the value that would come to the cause of tuberculosis by such a course, and offer their services equally to all patients who offer a reasonable chance of improvement or cure; consequently, complications are considered part of the disease and any complication which does not make the patient annoying to those near him, does not disbar him from institutional care. Most institutions are provided with an infirmary so that they can care for either advanced or early cases, and can take care of those suffering from complications as well as uncomplicated and easy cases. Many complications such as those on the part of the larynx and genitourinary tract are successfully treated. It is not unlikely that many of the slighter infections of the bowel also heal as a result of the care that is here instituted, although severe cases, in all of these situations, offer little hope. The patient can receive better care, however, than is possible in his home, and he can receive greater opportunities for cure than is possible to afford him outside of an institution. Cases of tuberculosis of bones and joints are ideal for institutional care because these patients need the out-of-door life and the rest and care. They need the same care that is demanded by tuberculosis in general, plus that which is specially directed toward the bones and joints themselves.

Length of Treatment.—When sanatorium treatment was first instituted it was hoped that two or three months would be sufficient for obtaining a result. We now know, however, that this is impossible. The pathology of tuberculosis is such that changes in it are slow. I find in observing many early cases of tuberculosis, where the clinical symptoms have not been severe nor the pathology extensive, that changes continue in the tissues for a year or more after arrestment has been attained. It is not necessary that the patient should be under active treatment all the time; but he should be under active treatment until his vital powers have been raised to such a point that they are capable of preventing a further spread of infection and until the infiltration in the lung can be well started toward conversion into fibrous tissue. A clinical healing and a pathological healing are two widely different processes. By a clinical healing I mean freedom from clinical symptoms of all character. Such a state is often arrived at after a few months, while a pathological healing will require many months. We must not consider the tuberculosis alone in treating these patients. We must consider the patient as an individual. We have an individual who has a tuberculous infection in his body who is constantly facing the danger of further spread of the disease. We must rely upon his resisting power to prevent the further metastases. This resisting power depends upon his cellular activity. If his circulatory, respiratory, digestive, and nervous systems are in good functionating condition, the chances of his having further extensions of the disease, are much less; consequently, I do not consider that we have done justice to the patient until we have given him the best nervous system possible, strengthened his heart, improved his digestion, and thus brought up the functions of the body to a point of efficiency so that all combined will give him a protective power capable of preventing a further recurrence. Consequently, I look carefully to the nervous condition of these patients. I endeavor to put them in such a condition of cellular efficiency that they can overcome whatever disturbances are present. I always try to relieve and prevent constipation; and put the patient in the way of understanding the peculiar forces which are operating to produce this condition.

I endeavor to show my patients the importance of keeping up their physical strength and their powers of physical endurance. All of this takes time. It cannot be accomplished in a short period. If the disease is advanced and the patient has suffered from prolonged toxemia he should remain under care until his physiological balance has been thoroughly restored. It is the metabolic equilibrium of the patient that must be considered. If we can raise the patient's powers to the point where he can produce more strength than is being expended and have reserve energy, his chances of relapse are much less than they are when we are unable to establish such a balance; consequently, tuberculosis should be treated for a long time; the early cases should be treated for an average of six months, sometimes a little more. Patients with advanced tuberculosis should be in a sanatorium from nine to ten months, or even a year. Patients who are still further advanced must remain even longer. Being convinced by my observation and experience that healing does not take place even during these long periods of treatment, I have been in the habit of advising my patients to return within six months to a year from the time they finish their first course of treatment, and again the following year, to undergo treatment again for a period of two or three months. By so doing the patient's resisting power is increased just at a time when it otherwise might be lagging. With such a method results are far more favorable and relapses are less frequent. To be sure, such a course is not imperative; but, when the disease has extended and the life of the patient is at stake, it is well worth the time and money expended. This shows the difference in the cost of effort and money between early and late tuberculosis. The cure of early tuberculosis is comparatively simple; the cure of advanced tuberculosis is more difficult, for the physician, as well as the patient, and proves expensive to both.

Success Depends on Intensive Treatment.—Success in an institution depends on a full program. One of the serious problems in all sanatoria is that of finding occupation for the patients. There are so few games and sports that the average patient can enter into advantageously that it forces those in authority to keep the patients happy and contented without employing the usual forms of diversion. When patients are in the early stage of the disease a minimum of riding and driving can be permitted. When the patients are in the more advanced stage of the disease, then these must be denied. No game must ever be entered into by the tuberculous patient that he cannot quit at any time should it tire him.

One of the most dangerous times in the life of the tuberculous patient is the time when he is given greater privileges, when he is allowed to begin to exercise and engage in diversions. If he is allowed to engage in very vigorous sports or go driving, he at once begins to overrate his strength and underrate the desirability and necessity of continuing to follow a definite program. The interest in cure is displaced by the desire for diversion. Entertainment is considered of more importance than attention to routine. The old adage of ''giving an inch and taking an ell'' is all too true of the tuberculous patient. The patient must be particularly guided at this time or over-confidence will displace judgment.

I have found that the best way of helping patients to occupy their time is by breaking up the day and having some little thing in treatment carried out at intervals during the day. In the Pottenger Sanatorium we have met this by giving the patients a carefully planned continuous program, as described in one of my previous papers,[10] as follows:

"The patient's day begins at 7 o'clock in the morning, at which time the nurse calls to waken him and to carry out any regular orders given by the physicians. The patient arises and takes a cold sponge bath, or, if he is not in condition to take it himself, it is given to him by his nurse.

"At 7:30 the medical director begins his daily rounds and continues until he has visited each bed patient. These visits are made in company with the assistant physician who has charge of the individual case. The condition of each patient is carefully noted, and the plan of treatment for the day agreed upon.

"At 8 o'clock breakfast is served, all patients who are able to be up and around going to the dining room. Those who are confined to bed are served in their rooms and bungalows. After breakfast each ambulant patient reports to the medical director for consultation. If any special treatment is needed he is referred to the assistant physician having charge of the case. All who are suffering from local complications, as of the ear, throat, or nose, are also treated at this time.

"On one day each week, between 10 and 11 o'clock, the patients are weighed by one of the staff.

"During the time between 9 and 1 o'clock the nurses are busy carrying out the physicians' orders and looking after the wants of the patients, devoting most of their time to those confined to bed.

"From the time that the patients are through with their treatments until 1 o'clock, they while away the time in croquet or other allowable games, in visiting friends and doing little things of a personal nature, and in exercising as prescribed by the medical staff.

"The medical director, aided by the assistant physicians, makes a careful examination of each patient monthly, charting the chest so as to note changes in the tuberculous process. These examinations are made between 10 and 1 o'clock.

"Lunch is served from 1 until 2 o'clock. From 2 to 4 o'clock are rest hours, during which time all the patients recline in their rooms and bungalows, and are instructed to rest, to sleep, if possible, providing it does not interfere with their sleep at night.

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[10] The Tuberculosis Sanatorium and What It Stands For, Monthly Cyclopedia and Medical Bulletin, April, 1911.

"At 4 o'clock the nurses begin their rounds, carrying out the physicians' orders and attending to the wants of the patients. The assistant physicians make calls upon each bed patient in their respective services and any ambulant patients who are not feeling well, and administer any special treatments that are required. They likewise prescribe for any new symptoms or complications that may have arisen since the morning visit.

"From 6 to 7 o'clock dinner is served. After dinner the patients usually amuse themselves by reading or games until bedtime. Bed patients, as a rule, go to sleep about 8 or 8:30, and all are required to be in bed with lights out by 9:15.

"It can be seen that the keynote in this program is close personal attention, and that it is so arranged as to keep the patients busy and interested in getting well. It may be said that such attention as this is far more than is necessary for tuberculous patients. My only reply is, that results warrant its employment. Such a program as this has produced an apparent cure in nearly 90 per cent of incipient cases, in 60 per cent of moderately advanced cases, and a healing or arrest in about 40 per cent of advanced cases."

CHAPTER XLIX.

PROPHYLAXIS.

The prevention of tuberculosis is far more important than its cure; consequently, all those who are attacking tuberculosis in any of its phases should become practical sanitarians. All prophylactic measures are directed toward the following purposes: first, to prevent infection from occurring; second, if infection occurs, to prevent the disease from becoming an open lesion; and third, if the disease does reach the open stage, to prevent the scattering of infection.

Infection of the Child.—Statistics show that practically every child is infected with the tubercle bacillus. We can hardly conceive of a human being reaching adult life without such an infection having taken place. This tuberculous infection produces two results,—one, salutary, the other deleterious. If the infection is slight it may be overcome by the tissues and result in healing. As a result of the infection, the body cells are so changed that they are endowed with the specific power of repelling further infections of the bacillus. In other words, these primary infections result in immunity. If the infection, on the other hand, is produced by large numbers of bacilli, and if the pathological process which follows becomes extensive, healing does not result readily. While the infection may be held in check for a period of time, sooner or later it is apt to extend and produce clinical tuberculosis. Whether immunity or clinical tuberculosis results is largely a matter of dosage of bacilli. We cannot wholly deny that there is such a thing as a predisposition of tissue and that one person offers better soil than another; nevertheless we are led to believe by clinical observation as well as experiment, that if we could control the number of invading bacilli we could make the infection salutary rather than detrimental, we could produce an immunity rather than a clinical tuberculosis. Children are taking into their bodies more or less constantly, staphylococci, streptococci, pneumococci, and other infectious bacteria, which are destroyed without producing disease. If the dosage is within their powers of defense specific immunity is developed, and clinical disease does not result. So is it with tubercle bacilli. The difficulty lies in the fact that the numbers of bacilli which produce the infection are too great for the child's defensive powers; and it should be the purpose of sanitarians and clinicians, who are dealing with these problems, to attempt in every way possible to destroy bacilli, so that the number which are taken in by the child will be few rather than many. To this end children should be removed from the presence of patients suffering from open tuberculosis until such a time as they have developed a specific cellular defense. This means that the child should not be permitted to exist in an environment where there are large numbers of bacilli during its earliest years. It should be spared this exposure, at least until it has had an opportunity to casually come in contact with small numbers of bacilli. Repeated inoculations of few bacilli will eventually result in an infection in most children, but an infection mild in character, which builds up a specific cellular defense and furnishes the child with a protection which saves him from falling victim to larger numbers of bacilli.

The greatest danger to the child is during the first two or three years of life. While from 80 to 90 per cent of children who receive a severe infection from tubercle bacilli during their first year of life die of acute tuberculosis, 50 per cent recover after the sixth or eighth year has been attained, and by the time the tenth year has been reached, acute tuberculosis is very uncommon. This shows that the time to shield the child in order to prevent clinical tuberculosis is during the first two or three years of his existence. Children of this age should not be permitted to live in rooms occupied by tuberculous patients. Bacilli gravitate toward the floor and this is the particular zone in which the little child lives. Neither should a tuberculous person play with a little child, unless he has previously washed his hands. If he is scrupulously clean, however, there would not be great danger.

When one realizes the smallness of tubercle bacilli and the numbers of them that can be carried in small compass, he then begins to see how difficult it is to prevent the child from receiving inoculations of large numbers of bacilli if he associates intimately with a patient suffering from open tuberculosis. This is apparent from the fact that the tubercle bacillus is one eighty thousandth of an inch thick, and one ten thousandth of an inch long, and that a small fleck of dust can carry thousands of them. Fortunately, many of the bacilli are dead and the danger is much less than would actually seem. See Vol. I, page 561.

Tuberculous cattle should be segregated from the dairy herd and the child should be guaranteed milk free from the contamination of the tubercle bacillus.

The Role of the Lymphatic Structures in Protecting the Child From Severe Infection.—At birth the child is provided only with a non-specific protective mechanism. The principle role of defense is played by the lymphatic structures. Those mucuous membranes which are exposed most to infection, such as the pharynx and those portions of the gastrointestinal tract where stasis of contents occur, are provided with extra amounts of lymphoid tissue—tonsils and Peyer's patches. I have discussed this quite fully in a recent paper.[1] These structures are provided with many crypts which make it easy for the entrance and detention of bacteria; and they are rich in lymphatic elements for their destruction. They manufacture lymphocytes. During the early years of life we can see the protective role played by the lymphatic tissues as exemplified in those of the oropharynx. Through irritation enlargements occur and sooner or later the faucial tonsils particularly are apt to become infected with pyogenic bacteria. These structures are the graveyards for bacteria, but in spite of their activity bacteria now and then pass beyond them and gain entrance to the tissues in general. After passing through the first protective lymphatic structures, however, if not destroyed, they are carried to the lymph glands, where they are again subjected to conditions which are distinctly hostile to them. The enlargements of the cervical glands in little children, particularly children of the poor, is evidence that the infection has passed through the mucous membrane of the oropharynx or tonsils and has reached the second line of defense. Enlargement of these structures does not always mean that they are infected. Many times enlargement is evidence of their increased defensive activity. It is extremely important that the non-specific defense of every child be preserved and increased to the highest point possible until it has gradually come in contact with bacteria and has built up a specific cellular defense. By the time the child has attained the age of eight or ten years it has come in contact with most ordinary bacteria. It has combatted successfully most of the infectious diseases of childhood; it has come in contact with streptococci and staphylococci; and the various microorganisms which are responsible for the acute respiratory infections. It has further built up an immunity on the part of the cells either absolute or relative, which will protect it from future inoculations of these various bacteria. After this period the lymphatic structures are not so essential and can be sacrificed with less detriment to the child. As the child increases in years we may assume that the nonspecific lymphatic defense has been displaced by the specific cellular defense because the lymphatic structures gradually degenerate.

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[1] The Non-specific and the Specific Defense of the Child Against the Tubercle Bacillus, Journal of the American Medical Assn., 1916, vol. lxvii, No. 20, pp. 1409-1411.

It is a common practice today to remove tonsils from little children upon the least provocation. This practice is wrong. The little child needs the defense afforded by these structures and unless they should be the seat of a definite infection, which is rarely true in the little child, or they should be so large that they are interfering with nasal drainage and respiration, or are making pressure upon the eustachian tube, they should not be removed until the child has had time to come in contact with bacteria and build up a specific resistance. I do not wish to be understood as opposing the removal of tonsillar tissue when the damage which is threatening the child is greater than the protective role which the organ plays in defense, but I do wish to emphasize the importance of saving these structures for the little child in order that he may better combat infection. From the standpoint of prophylaxis, the importance of preserving the lymphatic structures deserves far more emphasis than it has received hitherto.

Early Clinical Tuberculosis in the Adult.—Tuberculosis in the adult is believed, in nearly all instances, to be an extension of a prior infection which took place in childhood, but failed to heal; consequently, if we would prevent clinical tuberculosis in the adult, it is necessary that we give attention to the healing of tuberculosis in children. We are not justified in looking upon the early infection in childhood with so little concern. Our knowledge that this infection creates an immunity probably has resulted in giving us a feeling of undue security.

Statistics show that this early infection heals in quite a large proportion of children, but that it also remains in a state of semiquiescence and now and then manifests itself as an active disease, in another large percentage. The statistics of Hart, which I have quoted in these pages, indicate that tuberculosis is found in the lungs of more than 50 per cent of adults coming to autopsy. These statistics show that if we would prevent the clinical disease in the adult we must give more attention to the healing of these early infections in the child.

Not only does tuberculous infection belong to the period of childhood; but the cure of tuberculosis depends upon adequate attention being given to the child during these early years. If, instead of passing over tuberculous infection lightly, and being satisfied with the knowledge that "all have it," we would face the situation squarely and recognize the necessity of its cure we would be doing the greatest service in prophylaxis.

The prevention of clinical tuberculosis in the adult after infection has once occurred, lies in the province of the family physician and pediatrician. What can be done to prevent this early tuberculous infection from producing metastases resulting in clinical tuberculosis in the adult? This is the important question before us. It is a simple matter to say that the infected individual should lead a life surrounded by hygienic conditions; that he should not indulge in excesses; that he should form such habits as will improve his general nutrition and keep his resisting power high; but, unless human nature should change, we cannot expect such a course to be followed generally. We can expect, however, that when metastases have occurred and symptoms of activity are present, that the individual will give a hearty cooperation to prevent further extensions of the disease. It is probable then, that the most that we can expect on the part of the adult is that he should cooperate with the physician in securing an early diagnosis when clinical symptoms and physical signs manifest themselves, and in giving a hearty cooperation to prevent its extension to the stage of open disease, after an early diagnosis has been made.

If tuberculosis could be detected and intelligently treated when it first manifests itself as a clinical entity, from 60 to 90 per cent of patients could be restored to usefulness; consequently, we must not fail to emphasize early diagnosis and immediate intelligent treatment as being of tremendous prophylactic importance.

Importance of Keeping Up Resisting Power.—This subject is receiving much attention today; and rightly so. If our theory that adult tuberculosis is a metastatic infection is correct, then we must search for those changes in the tissues which permit an organism which has been the host of the tubercle bacillus and kept it inactive, probably for years, to suddenly or gradually become overpowered by it. We must further endeavor to find out what the influences are which operate in this way. No doubt they are many. Insufficient food, insufficient sleep, insufficient rest, living and working under bad hygienic conditions, mental depression, disease and dissipation are among the factors which we recognize as being capable of depressing cellular activity and inhibiting the body defense, yet we are compelled to generalize rather than discuss specific effects in treating of this subject. Tuberculosis is most common among the members of the laboring classes. This has rightly called attention to the conditions under which the laborers work, and has resulted in improved sanitation of the workshop, office, and factory. This, however, is not sufficient, nor do I believe it the most important factor in prophylaxis. Laborers are in the factory and workshop from eight to ten hours a day. The rest of the time is spent elsewhere. What do they do during the hours when not at work? Do they rest and sleep sufficiently? The more I observe, the more I am convinced of the beneficence and restorative power of rest and sleep; and the more I am led to believe that the loss of sleep is one of the potent factors in lowering resistance. Loss of sleep is usually accompanied by other excesses and it is impossible to say that this one thing is responsible for a given effect; but I would suggest, in our investigation of subjects such as the incidence and cause of disease among workers, that we give as careful scrutiny to the habits of the workman as to the conditions under which he works. I have seen many patients who have secured an arrestment from clinical tuberculosis work under what we would not consider favorable conditions, and yet maintain health by living right the sixteen hours spent outside of the office and shop.

The individual can, if he will, usually create for himself an environment fairly satisfactory for maintaining health, even though the surroundings do not seem favorable. Any combination of numerous factors may be used to keep resisting power high. If the patient cannot secure proper ventilation of his working quarters, for example, he should try to stimulate his metabolic activity by other measures, such as tonics, air, and water baths. Health is not necessarily maintained by the application of any one given measure. A combination of several which seem of less importance may be substituted for the more important when it cannot be applied.

Open Tuberculosis in the Adult.—Open tuberculosis in the adult is probably the cause of most of the tuberculosis which affects the human race. The carelessness of one produces the disease in another. It would seem that with this knowledge there should be no hesitation in carrying out a comprehensive program for the prevention of open tuberculosis, and for the protection of others when that stage has been reached.

The open stage of tuberculosis is the danger stage. It is the stage to be prevented. In order to prevent the scattering of infection when the open stage has been reached, it is necessary that the individual should know that he has the disease. It is further necessary that he be instructed as to the danger of scattering infection and how this may be prevented. It is not sufficient that he should be instructed, but he should cooperate. If he will not cooperate willingly, he should be made to cooperate by law. Unfortunately, there are a certain number of people who are ignorant and who fail to cooperate on this account, and a certain number who are vicious and who show a disregard for other people's rights. The latter class is not found wholly among the ignorant.

The danger of infecting others is in direct proportion to the care with which the patient carries out rules of personal hygiene on the one hand, and the sanitation and degree of crowding under which the patient lives on the other. Where families live in individual houses, occupying several rooms, each individual, as a rule, having a room of his own, the danger of infection is not so great; but, in thickly populated quarters, where entire families live in one or two rooms, and these rooms, as a rule, are insufficiently provided with ventilation and light, the danger from an open case of tuberculosis is very great. From the close association which is forced upon such people, even those who have a protection from a previous infection might not have sufficient immunity to prevent infection when large numbers of bacilli are more or less constantly taken in.

Realizing the great importance of open tuberculosis in the production of infection, hospital provision should be made for such patients, particularly those who are living under bad hygienic and crowded conditions. These institutions should be made inviting and should be furnished with good service so that the patient will be contented and remain in the institution, either until he has secured a condition of arrestment or until death occurs. Adequate care for the open case is of vast importance in preventing further infection.

Sanitary Arrangement of Patient's Room.—While there is little that can be added in a work of this kind to the usual teaching which is so well understood today for preventing the spread of tuberculosis, yet I shall endeavor to discuss some of the more common prophylactic measures from a practical standpoint. Simple and adequate instructions may be found in the books of Knopf, Flick, Otis, Brown, and Hillier.

In our prophylaxis, we are striving at an ideal, but we should not let our idealism carry us so far that we become impractical. Unless we have institutional provision for the advanced cases of tuberculosis, it devolves upon the attending physician to arrange the home in the way that it may be adapted, as nearly as possible, to institutional ideals. In the homes of the well-to-do, this can be done with comparatively little difficulty. In the homes of the poor, however, the problem is more difficult. Where possible, sunlight should be in every room occupied by a tuberculous patient, because sunlight is the most deadly enemy that we have of the tubercle bacillus. Sunlight will destroy tubercle bacilli almost as fast as the sputum containing them dries. Diffuse light will destroy them also, but it takes several hours to do so. There is considerable doubt whether it is possible for a patient to become infected with tuberculosis from dust in the open air, particularly in a country that is flooded with sunlight. In the closed rooms of homes and shops, and other protected places, where light does not readily enter and where conditions of moisture exist, bacilli may live for a prolonged period of time and still be able to produce infection. I have far more faith in the germicidal action of sunlight or diffused light than I have in chemical methods of fumigation. Both should be used, however. If one can secure a light, airy room, in which the sunlight enters readily, he has done a great deal toward preventing the further spread of disease.

Rooms should always be simple. Furnishings should be plain and easily cleaned. Heavy draperies and upholstering may add something to the comfort of the patient, but these should be dispensed with for the sake of cleanliness. When one realizes that one thousand tubercle bacilli may pass side by side through a pin hole (Brown), one can understand how important it is that we use all possible precautions to prevent collections of bacillus-bearing dust, and to destroy infection.

There should be very little furniture in a room occupied by a tuberculous patient. A bed, table, dresser, and one or two chairs, is all that should be allowed. This insures a more thorough cleaning of the room than where more furniture is permitted. Bare floors are preferable to carpets. These may be mopped frequently; and, in this way, most of the infectious material which escapes the bactericidal action of the light, is removed from the room. Experiments have shown that nearly all bacteria settle within two or three feet from the floor; so, if the woodwork near the floor can be washed with water, or with water to which is added some antiseptic such as bichloride of mercury or common lye, the room will be rendered free from danger of infection. Whenever practicable, the floor should be washed and not swept; when not practicable, damp sweeping should be resorted to, the floor being sprinkled with water, wet pieces of paper, tea grounds, or some such material.

Dishes and tableware used by the patient with open tuberculosis should be kept separate from that used by other members of the family. They should be scalded or boiled after every meal.

Personal Hygiene.—The personal hygiene of the patient, after all, is the most important factor in preventing the spread of infection. If it were possible for the patient who is suffering from open tuberculosis, to destroy all of his bacillus-bearing discharges, we could readily eliminate the largest factor in the spread of this disease.

Dust Infection.—Tubercle bacilli are scattered by the patient suffering from open tuberculosis largely in two ways; first, through dried sputum; second, by droplet infection. The greatest number of tubercle bacilli are cast out in the sputum. The number expelled daily varies greatly. In a study of this question in the Pottenger Sanatorium during the past year, we estimated that one patient expectorated thirty billions of bacilli per day. It has frequently been estimated that the average advanced tuberculous patient will expectorate six or eight billions per day. Personal hygienic measures which are commonly carried out now take care of most of these bacilli, when the patient is under intelligent care, because the sputum is collected and destroyed. Unfortunately, there are a great many tuberculous patients who are expectorating bacilli every day without knowing that they have the disease. These patients go about, scattering infection wherever they go. (See page 561.)

There is no effective way of taking care of tuberculous sputum which does not offend the delicate sensibilities to a certain extent. At the same time we find that a very large per cent of patients are willing to sacrifice their personal feelings for the good of the many. A paste-board sputum cup, which can be burned, is a very efficient way of destroying tubercle bacilli. Where this cannot be used, metal or earthen cups may be employed. Where such are used, the contents should be destroyed by boiling, and then be emptied into the sewer. Washable cloths should not be used. Paper napkins are quite good. When cloths or paper napkins are used, they should be burned before the sputum dries. The whole aim in taking care of sputum is to have it destroyed before it dries and passes as dust into the air. Expectorating in streets, public places, public conveyances, workshops and houses, as is sometimes done by the ignorant and willful, is a very common method of scattering infection. Sputum on the sidewalk and in the street is picked up on the shoes and skirts and carried into the home to, infect the children. There is no doubt that many infections are to be traced to this method of scattering infection.

Droplet Infection.—This is the name given the other chief way of scattering bacilli. When the patient coughs there is a fine spray scattered within a radius of two or three feet around him. This fine spray will remain in the air for a prolonged period of time. It contains bacilli in particles of mucus in a viable form; consequently, if such bacilli gain entrance to the body, infection is more likely to occur than from bacilli contained in the dry sputum. The bacilli scattered by droplet infection are in a more viable form and have been less injured by light prior to the time of inhalation than those which are found in dried sputum. Droplet infection could be prevented by the patient covering his mouth during coughing. This might seem easy to do, and yet it is not so. There are times when it is very difficult for the far advanced patient to cover his mouth during a severe paroxysm of coughing, with its attendant dyspnea.

Bacilli in Feces.—The question of scattering infection through fecal discharge is one that deserves more attention than it has previously received. The patient suffering from tuberculosis swallows large amounts of sputum. The extent to which tubercle bacilli may be found in the sputum may be inferred from the studies made in the Pottenger Sanatorium, given elsewhere in these pages, which show that 50 per cent of patients suffering from open tuberculosis have bacilli in their feces in such amounts that they may be determined by simple smear examination, following homogenization. It has been heretofore taught that the decomposition which takes place in the sewer is sufficient to destroy tubercle bacilli; but the report made by Brown, Petroff, and Heiss[2] shows that these bacilli do not die as quickly as has been supposed. These experiments, however, come from a city which has an unusually large number of tuberculous inhabitants. The fact that viable bacilli were found two miles below the entrance of the sewer is quite important. The fact, however, that no viable bacilli were found five miles below, is equally important. It is another proof of the fact that dilution and the process of purification which takes place in water will soon destroy bacteria, or make them harmless.

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[2] Occurrence of Living Tubercle Bacilli in a River Contaminated with Sewerage from a Health Resort, read before the Association of American Physicians, Washington, D. C., May 9-11, 1916, American Journal of Public Health, November, 1916, vol. vi, No. 11.

Bovine Infection.—The amount of tuberculosis conveyed to the human being through milk is as yet uncertain. While many observers, basing their views upon the percentage of bovine infection found in a given series of cases suffering from tuberculosis, have concluded that probably 8 or 10 per cent of all tuberculosis is of bovine origin, there are other factors which enter into the question that prove these statistics to be unreliable.

The question of transmutability deserves far more consideration than it has received (see Volume I, Chapter II). It seems to me that the mutation of species is the only thing that will satisfy the conditions which we meet in actual practice. We cannot conceive of a large proportion of individuals having bovine tuberculosis in childhood, and believe that the infection in childhood is the one that produces the metastases in later life, and still believe that the infection in later life is all of human origin. We must either recede from our belief in adult tuberculosis being metastases from the infection in childhood, or we must believe that mutation occurs. It is not at all improbable that bacilli growing upon the same medium (human) for a period of ten, twenty, thirty, or forty years, would assume the characteristics of bacilli which are naturally adapted to that medium.

It would seem that the eradication of tuberculosis from the dairy herd would be simple, but this is not so. A herd of valuable cattle is not sacrificed willingly. The dairymen will make the excuse that the pasteurizing of mik removes the danger, and this, probably being true, makes it almost impossible to eradicate tuberculosis from the herds. If it were possible to destroy all tuberculous cattle and to compensate the cattle owner for them, for the benefit of society, in that way the disease could be quickly stamped out.

The Part of the State and Municipality in Preventing Tuberculosis.—Tuberculosis is essentially a social and economic disease. The amount of tuberculosis present in any population depends upon the social and economic status of that particular population. This has been shown by statistics from many different writers. The census of New York has shown that there is fourteen times as much tuberculosis in the crowded districts of the city as around Central Park. In a census made in Vienna a few years ago it was shown that tuberculosis was thirteen times as common in the crowded quarters of the working people as in the sections occupied by the well-to-do. This question has been studied from another angle, and it has been shown that the amount of tuberculosis is in direct proportion to the income of the workers. All the investigations that have been made go to show that the causes which operate to increase clinical tuberculosis are those which favor overcrowding and low standards of living; consequently, it is the duty of the state and municipality to do what it can to improve the homes of the working class. This condition can be improved through education and through salutary laws. Regulation of tenement construction is a forward step toward the prevention of tuberculosis. Public parks and playgrounds which improve the ventilation of the city and permit better air to be furnished to the inhabitants, are very efficacious. Playgrounds also give the children an opportunity to improve their physical development and grow stronger. Thus it helps them to overcome the early infection which they have received, and secure a degree of strength which fortifies them against the further spread of the disease. Another method in which the municipality can aid in this work is to furnish salutary amusements for the people so that harmful pastimes will be avoided. While the municipality cannot prescribe open air life, and cannot regulate proper hygienic arrangements of the individual home, it can compel the construction of houses and workshops which will give a sanitary environment. It can also regulate and control child labor, and in many other ways, either encourage or enforce measures looking toward the improvement of the health standard of the individual.

The schools require more healthful supervision than they have had in the past. The construction of the buildings should be carefully guarded. There should be a standard of ventilation which could not be changed by the whim of a teacher or parent. Sanitarians should devise the degree of ventilation which is required for school rooms, and this should be provided for every building. Medical inspection of children should be an integral part of the school curriculum. School authorities should recognize the fact that during the period of development they have the children under their care for about one-fourth of each day; and it should be their duty to see that the children not only receive proper instruction in healthy living, but that they be examined for defects that can be corrected. Children should be put in such a physical state that they are able to carry on their work to best advantage.

These prophylactic measures have a tendency to prevent the infections of early years from producing metastases which result in clinical tuberculosis. When clinical tuberculosis has developed, then it is the duty of the municipality and the state to provide the opportunity for cure for the early cases and a home with such treatment as is necessary for the bacillary cases. Thus, all of those who may be, should be restored to usefulness, and those who cannot be, should be cared for until death relieves them. This may be looked upon as an expensive program, but it is the only program that gives justice to both those who are already infected, and those who are not. The state should further carry on a campaign of education, instructing the people in the simple facts regarding early diagnosis, and prevention of this disease. Public lectures should be given wherever the opportunity arises. Nurses should be maintained who are able to go to the homes and instruct the people in right methods of living and in the measures which are necessary to prevent the scattering of infection. Dispensaries manned by competent experts should be provided where those suspected of having the disease may go for consultation and advice.

Marriage.—The question of marriage must be discussed from the prophylactic standpoint. Precedent to any discussion of this question we must bear in mind that the tuberculous patient has the same desire for home and parentage that the non-tuberculous has. It is a perfectly legitimate desire, and in the treatment of this question it is necessary for sanitarians to bear in mind that the parental instinct is the strongest instinct in the human race. It is necessary to make our advice in this matter practical, even though it may depart from some of our ideals. Is the marriage of a tuberculous patient a danger to the other spouse? Patients who have had clinical tuberculosis, but who have not reached the bacillary stage should, after attaining an arrestment, and remaining in a state of health for a period of two or three years be considered from the standpoint of marriage in practically the same light as those who have not previously been clinically ill. There is no reason why, if such patients are willing to follow out a hygienic life, avoid excesses, and other things which have a tendency to lower their vitality and produce activity in their focus of disease, they should not marry the same as those who have not suffered from clinical tuberculosis. There is neither danger to themselves nor to their offspring.

While it may be possible that tubercle bacilli can be transmitted to the offspring through the placenta, yet this is so uncommon that it need receive very little attention at the hands of sanitarians. Tuberculosis as an inherited disease has been found only sufficiently often to make it a pathological possibility. Pathologists deny that this is a common method of transmitting tuberculosis.

The important questions of a prophylactic nature for discussion in relationship to marriage are the likelihood of the other spouse being infected and the danger of infecting offspring after birth. Open tuberculosis cannot be looked upon as lightly as early clinical tuberculosis, prior to the time that bacilli appear in the sputum. Even should the patient obtain an arrestment of the trouble and an elimination of sputum, if the disease has been widespread, there is still considerable danger of a relapse in after years during or following pregnancy. There is no objection to such a woman, who has secured an arrestment from advanced tuberculosis, marrying, provided she can have conditions which are favorable to retaining the degree of health obtained, and providing she is willing to be carefully guided by some intelligent counselor as to the advisability of bearing children. Patients with open tuberculosis should not bear children; and, in case children are born under such circumstances, they should be removed at once from the dangerous environment of the mother. If such children are removed at once, there is no reason why they should not be as free from danger of infection as any other children.

The question is often discussed whether a child born from tuberculous parents is any more inclined to tuberculosis than a child born of non-tuberculous parentage. This question must be considered in the light of our knowledge of resistance to infection. We cannot grant that there is anything specific in the inheritance from the tuberculous parent that makes the child more susceptible to tuberculosis than a child born from parents who are suffering from reduced vitality from any other cause. All things being equal, the stronger and healthier the parents the stronger and more resistant the child.

Are Open Cases of Tuberculosis a Danger in a General Hospital?—This question is a very important one from the standpoint of justice to the tuberculous patient, as well as to those who are not infected. If it were possible to decide this question it would offer a solution for a very vexatious problem. Patients in the bacillary stage are taken into general hospitals when they require operation, but rarely under other circumstances. It is often advisable to take such patients into the hospital for general observation, and it is sometimes necessary to do so for treatment; yet, if he is a danger, and the lives of others are endangered by this procedure, it should not be done, or only in cases of greatest emergency.

If our modern theories of infection are true, there is little danger of an adult becoming infected with tuberculosis. The infection which takes place in the child creates a specific cellular defense which lasts throughout life. While this defense must be considered as relative, and not absolute, yet it is believed by such students of phthisiogenesis, as Römer, Hamburger, and Baldwin, that it is sufficient to give almost absolute protection against further exogenic infection during life.

While this theory is not yet thoroughly proved, and there seems to be no way of determining it with absolute certainty, yet it seems to meet the conditions presented by this chronic disease better than any other theory. Superinfection in animals not only takes a chronic course, but is accompanied by a definite tendency upon the part of the tissues to throw off the infection. It would seem that the specific cellular defense is such that only by massive inoculation can further infection occur. This I have discussed elsewhere in these pages. From within, however, the case is different. Bacilli which escape from the foci which already exist within the body, find themselves already within the tissues and are not compelled to make an entrance before infection can occur. They escape now and then from the foci of infection in large numbers,—numbers too large to be successfully combated by the existing protective elements. Under such conditions metastatic infection can occur. We can conceive of a condition arising whereby the adult, through close personal contact with an open case of tuberculosis, might develop an exogenic infection in spite of marked specific cellular defense. That this does not occur often, however, we are led to believe from our study of the behavior of tubercle bacilli which escape from open lesions in the lung and pass down over the bronchial mucous membrane; or, in case of swallowing, over the intestinal mucous membrane. These mucous membranes offer marked resistance. It is only after prolonged contact under conditions which tend to lower the defense of the patient, that we have surface ulcerations in such tissues as the larynx, trachea, and intestinal tract. From this observation, also from the observation of animal experiments, as well as from our theoretical considerations, we are led to believe that adults are exposed to very little danger in a casual association with patients who are suffering from open tuberculosis; consequently, we are led to believe that the tuberculous patient in the general hospital, even in the open ward, is not a danger to the other inmates of the institution.

Practical proof of this conclusion is found in all institutions where tuberculous patients are treated. The attendants of these institutions, instead of being prone to infection, seem to show even a smaller number of infections than occur in human beings generally. The same is true of the laryngologist who deals with tuberculosis of the larynx. The same has been shown in marriage, where one or other of the parties is infected with tuberculosis. Considering the great number of cases of tuberculosis, infection in the other spouse is exceedingly uncommon. This observation goes back prior to the time that we used intelligent measures for the prevention of the spread of the disease; prior to the time when the cause of tuberculosis was known; even prior to the time that care was exercised in the disposal of sputum, and when not even ordinary precautions were taken to prevent the soiling of furniture and clothing by sputum.

From this, we are led to believe that with the observation of modern precautions, including careful personal hygiene, as well as hygiene in the hospital, there is no danger to the inmates should a tuberculous individual occupy the same ward. This belief, however, should not be taken to warrant any relaxation in our hygienic measures. Every precaution should be taken to destroy the bacillary discharges and to reduce the danger to a minimum. Washing of the room and disinfection should be carried out to the fullest extent possible.

Phthisiophobia.—Phthisiophobia is a modern disease. It affects alike both those who have tuberculosis and refuse to accept it, and those who are not infected. Phthisiophobia is based on ignorance. Sufficient knowledge of tuberculosis and the tuberculous patient would remove it or make it assume an intelligent form. The fear of tuberculosis results from the teaching that tuberculosis is an infectious disease. When people learn this they do not go further and learn that the infection is one of mild degree, and that the greatest danger of infection is in childhood, prior to the time that the individual has developed a specific resistance to the bacillus. On learning that it is infectious, they class it at once with smallpox, scarlet fever, diphtheria, and other infectious diseases that they know.

To prove that tuberculosis is either a very mild infection, or that the human being is enabled to withstand repeated inoculations of bacilli, it is only necessary to bear in mind that each patient who dies of tuberculosis is ill of open tuberculosis on an average of three or four years, and that during this time bacilli are expectorated ranging in numbers from a few thousand to many millions, even billions, during each day. It requires only a few tubercle bacilli, if they are inoculated into an individual at the right time and under the right circumstances, to produce infection, yet, in spite of all this pouring out of bacilli during many months and many years, the number of deaths from tuberculosis is gradually decreasing. We cannot say that the number of infections is decreasing; but, through hygienic measures, better living, a better understanding of the life history of the disease, tuberculosis, we are removing the child to a certain extent from the danger of severe infection; and improving the general resisting power of individuals in general so that fewer patients develop active clinical tuberculosis. These facts indicate that tuberculosis is not so severely infectious as to make us shun those who are unfortunate enough to suffer from the clinical disease.

An intelligent effort should be made to place the infectiousness of tuberculosis before the public in the right way. It is a communicable disease. It is communicated by one who has the disease to one who has not, probably most widely during the first few years of life. The only source of human infection is the discharges from the tuberculous ulcers, principally those in the lung. It is also communicated through infected milk. Care on the part of the tuberculous patient takes away most of the danger of infection and the removing of the child from the tuberculous environment, and withholding from him milk that is infected, will take away the greatest source of danger. The child will probably become infected anyway, even though these three greatest sources of danger are removed; but the infection will be so gradual, and the numbers of bacilli will be comparatively so small, that the resultant infections will be eventually overcome by the defensive forces of the child. Thus, healing will result after infection has stimulated the body cells to the production of specific defense.

There is no danger from the breath of the tuberculous patient. There is no danger from being in a room with him, if he is careful, and particularly is there no danger in being in the open air with him.

Physicians spread phthisiophobia. Some of the worst instances of phthisiophobia that have come under my notice have been those which were stimulated by physicians. Many physicians, when they suspect tuberculosis in a patient, instead of being honest and telling him that he has the disease, tell him "he is threatened with the disease," and that "he must not go near tuberculous patients, lest he become infected." The result is that such patients fear to come in contact with anyone who might have the disease; when, very often, they themselves, are infecting their children and the children of their friends. Phthisiophobia can best be overcome through the teachings of the medical profession, and it is well for them to start in their own ranks.

CHAPTER L.

TUBERCULOSIS CLINIC.

In the following pages I have attempted to illustrate many of the important facts related to clinical tuberculosis. In order to do this I have chosen patients representing various types of the disease and many of the common complications met in practice. I have not attempted to choose favorable cases, but have taken the common types. We often learn more from patients who die than those who live, so I have chosen several who went on to death, some of whom were examined postmortem. I have discussed these cases particularly from the following standpoints:

1. The relationship of the clinical history prior to the time that the disease was recognized to the diagnosis. In this I have endeavored to point out the errors and shortcomings in diagnosis, and the mistaken advice which was often given to the patient.

2. I have discussed the examination of the patient detailing the results of inspection and palpation, as well as the results obtained on percussion and auscultation. In this manner I have endeavored to impress upon the reader the importance of inspection and palpation and show how by these methods alone a diagnosis can be made in patients suffering from tuberculosis. In this manner I have hoped to emphasize important but neglected diagnostic measures.

3. I have endeavored to describe the course of the disease during treatment and to show the relationship between the pathology and the clinical symptoms as presented. I have tried to give the reader a comprehensive view of what clinical tuberculosis means, as illustrated during the course of observation. While the complete visualization of the pathological changes in a lung in advanced tuberculosis is impossible, yet it is necessary for the clinician to strive toward this end.

4. I have discussed the treatment of the disease and its complications with the hope that this might aid those who have not yet had great experience in treating this disease to a better understanding of the therapeutic principles employed.

In order to obtain most value from these illustrative cases, the reader should study the appended charts and follow the temperature and pulse curves closely; particularly is this necessary while reading the paragraphs on "Course of Disease During Treatment." At the lower margin of the charts is appended the dosage of tuberculin. It will be noticed that I use the combination of letters and figures as suggested on page 361, Chapter XL, Volume II. The important clinical notes are also written in the charts. While there are many other notes that might have been attached, yet it seems better only to append notes of the more important symptoms and complications to the temperature and pulse curves.

The figures representing the chests and those showing the temperature and pulse will be found at the end of each case. The upper curve is that of the pulse, the lower that of the temperature, the same as in all other charts throughout the work.

CASE 2668.

CHRONIC FIBROID TUBERCULOSIS OF HILUS AND RIGHT LUNG IN PATIENT OF NEURASTHENIC TYPE; LONG DELAYED DIAGNOSIS; ARRESTMENT OF PROCESS; MARKED IMPROVEMENT IN NERVE TONE. OBSERVED FROM APRIL 30, 1915, TO JANUARY 14, 1916.

A DISCUSSION OF: THE IMPORTANCE OF FREQUENT AND REPEATED COLDS AS A SYMPTOM OF ACTIVE TUBERCULOSIS; THE EFFECT OF PROLONGED SEMIQUIESCENT TUBERCULOSIS UPON THE PHYSICAL DEVELOPMENT AND NERVOUS STABILITY OF THE PATIENT; TUBERCULOSIS AND NEURASTHENIA; TREATMENT OF THE NEURASTHENIC PATIENT; AND THE RELATIONSHIP OF THE TEMPERATURE CURVE TO PATHOLOGICAL HEALING.

Case 2668.—Teacher. Age 28. Entered the institution April 30, 1913.

Family History.—Mother died in childbirth. Father died at the age of fifty-six of arteriosclerosis.

Personal History.—Never strong. Had typhoid fever at the age of 10. Usual diseases of childhood. Menstruation normal for first few years.

Tuberculous History.—During the past twelve years the patient has suffered from protracted colds each winter. These have become more marked and more chronic during recent years. She has suffered considerably from malaise, and lack of endurance, and an increasing inability to do her work. There has been slight disturbance in appetite, although it was always capricious. Hoarseness has been a very common symptom, with some tickling in the larynx and tendency to cough. Attacks of bronchitis have been frequent, sometimes starting in the chest, at other times starting as a rhinitis, or laryngitis, and ending as a bronchitis.

These symptoms may be classified, according to their etiology, as follows:

SYMPTOMS DUE TO

Toxemia	Reflex Stimulation	Tuberculous process *per se*
Malaise Lack of endurance Nervous instability Capricious appetite Suffered from loss of weight at times, but not regularly	Hoarseness Tickling in larynx Cough Pain in shoulder	Tuberculous bronchitis

Examination.—The patient was of the asthenic type, tall and slender, lacking both in nerve and physical force. Temperature normal, pulse between 75 and 85. Blood pressure 130 right, and 123 left. Bowels regular.

Condition of the Muscles and Subcutaneous Tissue.—The condition of the muscles and subcutaneous tissue is shown in the following table in which the — sign is used to indicate degeneration, and the + to indicate spasm. The degree of spasm and degeneration is indicated by the number of signs; one, meaning slight; two marked, and three very marked.

	RIGHT		LEFT	
	Degeneration	Spasm	Degeneration	Spasm
Sternocleidomastoideus	—	+		
Pectoralis	— —			
Trapezius	—	+		
Rhomboideus minor	—	+		*
Degenerated subcutaneous tissue	Marked to third rib anteriorly, and middle of scapula			
Lessened motion.	Slight, particularly over the apex			

*The marked spasm of the left rhomboideus minor was irregular and did not correspond with other conditions found. The cause of this was occupational. The patient had been driving a Ford and cranking it with her left arm. A very common cause of increased tone in the rhomboideus minor is cranking an automobile, playing tennis, using dumb-bells, or some other such exercise, which causes an unusual use of this muscle. This must always be taken into consideration in determining whether or not the cause of the spasm is occupational or pathological. When this muscle alone is the seat of spasm, occupational influences should be considered rather than pathological change.

Deep Palpation.—RIGHT.—*Anteriorly.*—Moderate degree of increased resistance above the third rib. *Posteriorly.*—Same to spine of scapula. LEFT.—Nothing abnormal. The outlines of the heart were shown in their normal position.

Suggested Diagnosis from Inspection and Palpation.—From the fact that the muscles and subcutaneous tissue were both degenerated over the right apex, which shows increased density on deep palpation, we infer that this area is the seat of an old chronic inflammation. From the fact that the muscles are slightly in spasm, we infer that, at the present time, it is slightly active.

Percussion.—RIGHT.—*Anteriorly.*—Slight impairment to the third rib. *Posteriorly.*—Same to spine of scapula. LEFT.—Nothing abnormal.

Auscultation.—RIGHT.—*Anteriorly.*—Slightly harsh inspiration, with prolonged expiration in the upper portion above the third rib. *Posteriorly.*—Same to spine of scapula. The breathing was also impeded, the air not entering as freely as on the left.

Examination of Other Organs.—Slight pharyngitis; marked right dorsal and left lumbar scoliosis.

Sputum:	No sputum	
Urine:	Quantity	2850 c.c.
	Albumin	negative
	Sugar	negative
	Diazo	negative
	Indican	slight
	S. G.	1013
Blood:	Hemoglobin	85%
	Leucocytes	6550

Diagnosis.—Old chronic fibroid tuberculosis of the right apex, which has repeatedly been the seat of slight activity during the past twelve years. At the persent time the condition is not wholly quiescent. Fig. 142 is a chart showing the character of the lesion in this case. (See end of description.)

Prognosis.—The prognosis, from the standpoint of arresting the tuberculous process, is good. The interesting question, however, from the standpoint of prognosis, is the ultimate efficiency of the patient. Owing to the fact that the condition of ill health has existed so long, the probabilities are that she cannot be restored to more than three-fourths of her efficiency.

Analysis of the Case.—This patient represents a very common type met with in our daily practice. Owing to the fact that no organic lesion has been previously found; and owing to the lack of appreciation on the part of the profession of the importance of functional derangements, this patient was allowed to drift from year to year, gradually losing weight and efficiency, and becoming pessimistic as to her future usefulness. As a profession, we are alive to the importance of diseases in the upper air passages as etiological factors in the production of frequent and protracted colds. We are not, however, sufficiently alive to the fact that these are often caused by an inflammation of the bronchial glands or to disease within the lung itself. Any patient who is below par in nervous and physical strength, and who is continuously suffering from protracted colds, should have the mediastinal glands and the lung carefully investigated. The patient who suffers from repeated attacks of "colds," which always end up with cough and bronchitis, in the majority of cases, is suffering from a pathological condition of the bronchi or pulmonary tissue itself. The most common underlying pathology is that due to tuberculosis.

The nature of these attacks in this patient should have been suspected from the fact that each one was accompanied by symptoms of mild toxemia. The patient suffered from malaise, lack of endurance, instability of the nervous system, altered appetite, and some loss of weight. She found that she could not carry on her work. Temperature was not taken. Had it been taken a slight rise would probably have been found.

Such a picture is indicative of something serious, particularly when it is being repeated time after time. The most common cause for such is pulmonary tuberculosis. In this case this should have been all the more easy of detection because of the presence of the reflex group of symptoms pointing to the larynx,—hoarseness, tickling in the larynx with cough. The combination of symptoms belonging to all three etiological groups should leave no hesitancy on the part of the examiner in making a diagnosis of pulmonary tuberculosis. The effect of this tuberculous process which, now and then, over a period of twelve years, had exhibited activity has been very marked in its reduction of the efficiency of this patient. Toxemia shows itself most markedly upon the nervous system. It exerts its influence upon the central nerve cells of the entire nervous system and produces an irritability which, later, leads to exhaustion. It particularly, as I have discussed elsewhere in these pages, influences the vegetative nervous system, causing a continuous disturbance in function upon the part of important viscera, interfering greatly with metabolism. This patient was gradually becoming a hopeless neurasthenic invalid.

This type of individual is frequently met in daily practice, and the influence of tuberculosis in producing this condition must always be borne in mind.

Course of the Disease During Treatment.—An idea of the course of the disease as illustrated by the temperature and pulse curves may be obtained from Fig. 143. To produce a favorable result in the treatment of this type of patient is very important from the standpoint of future usefulness. It is not only our purpose to bring about an arrestment of the tuberculous disease, but we must, as far as lies within our power, restore this patient's efficiency. We must appreciate the fatigue from which the nerve cells have suffered, and give them a chance for recuperation; because, through this alone, can we bring about an ultimately satisfactory improvement in the physical strength and endurance of the patient. (Figure at end of description.)

My method of handling such a case as this is: first, I explain to the patient, carefully and systematically, the cause of the condition from which he, or she, suffers. Patients of this type suffer from pains; they have nervous instability; they become worried, discontented, and unhappy upon the least provocation. They are often sensitive and easily hurt. They fail to sleep as well as they should. In short, they manifest a train of symptoms which shows nerve energy exerted, not only inefficiently, but in wrong directions. They come to the place where they do not think correctly; they interpret wrongly; and, consequently, are greatly hampered in their work. It is important to overcome all of this, if we are to restore the patient.

To aid a patient who is suffering from nerve exhaustion it is necessary, first; to gain his or her confidence. I explained the situation to this patient in the following manner, which is somewhat crude, but which, at the same time, helped her to see what we were attempting to do and the necessity of following out a carefully planned program.

I told her that her nervous system was undermined, as a result of long continued irritation. This irritation had come from many sources. Part of it was due to toxins from various sources, one source of which was the tuberculous focus in the lung, which had thrown out toxins at intervals over a prolonged period of time. These had exerted their influence upon the cells of the central nervous system and had left them in an irritable condition. The patient had also suffered greatly from various depressing conditions such as disappointment, discouragement, and anxiety about her future welfare. I explained to her how these depressive emotions are also expressed on the central nerve cells. Toxins and depressive emotions particularly influence the sympathetic nervous system; and when this is stimulated over a prolonged period of time there results a general inhibition of the patient's conservative forces. Resulting from this prolonged stimulation the nerve cells had become so irritable that nerve action was unstable. Mental impressions were wrongly interpreted and motor and sensory impulses expressed themselves wrongly. The threshold of response for the nerve impulse had been lowered so that nerve action resulted at insufficient stimulation. This I explained graphically, as follows:

If we consider that it requires 100 per cent impulse to liberate nerve energy from a nerve cell under normal conditions, when these nerve cells become irritable and the threshold of response is lowered, nerve energy may be discharged at any point below 100 per cent. It may be at 75, it may be at 50; or, in extremely nervous individuals, it may be at 25 per cent. The result of this is that these patients have painful sensations with slight irritations which would not be recognizable if their nerve balance was normal. They are influenced wrongly by the sensory impressions which come to them. Even their methods of interpretation become altered and they fail to think straight. The whole nervous and psychical being is irritable and unreliable in its action. They are discouraged easily, and become worried and discontented when they would not, if their nervous equilibrium was not disturbed.

After giving this explanation, the next important step is to convince the patient that this condition can be changed. The fact that it can be changed is particularly impressed upon the patient by showing him or her that the condition has been brought about by many different forces, some of which are partly, or wholly, possible of control. One cannot, under such circumstances, promise to restore the patient to 100 per cent efficiency; but, in a very large percentage of cases sufficient irritation can be removed so that if the patient will give up the time to treatment, and follow out the program with a sufficient degree of intelligence and cooperation, a degree of nerve balance will be eventually attained which will greatly improve the patient's reactive powers, even though a high state of efficiency cannot be attained.

In the treatment of this patient, the influence of hopeful suggestion was soon seen. While at first she was inclined to feel more or less doubtful, and during one or two periods during treatment she lost courage and faith, yet this was quickly restored by the fact that she could see, when her case was carefully analyzed for her, that she was improving.

Rest is a big factor in these cases,—not only physical rest, but nerve rest. While I permitted her to do a certain amount of reading, sewing, and crocheting, and work of this kind, yet I made it a rule that she must never work to the point of tiring. It is well known that patients suffering from a condition like this tire easily both mentally and physically. It is just as essential not to have the patient tire in trying to restore a stable nervous system, as it is when attempting to restore a normal physical condition. The bowels must be looked after carefully so that no stasis with toxemia results from this source. Rest, together with good food and tuberculin, adds greatly to the psychotherapeutic handling of cases of this kind. Water and sun baths, carefully suited to the patient, also aid in improving metabolic activity.

As the treatment progresses the action of the toxins from the tuberculous focus gradually becomes lessened. The nerve cells are relieved to that extent. Better assimilation and improved elimination soon add their part, which also influences the nerve cells favorably. Hope and encouragement take the place of worry and disappointment and this relieves the constant inhibiting influence of these depressive emotions upon the sympathetic nervous system. As the irritation of the nerve cells becomes less, they recover tone. In this case, the patient soon had less pain; less anxiety; less inclination to worry; and felt more hopeful. Her digestion improved. She put on nearly twelve pounds in weight. The nervous system showed less irritability and all the functions of the body were carried on in a more satisfactory manner.

The influence of the therapy can be seen in the temperature charts. The nervous influences are shown very markedly upon the pulse and temperature during the early period of her treatment. It will be seen that the first two months showed a very marked irregularity. During the second month the pulse rate became more regular; during the third month still more regular; and, from that time on, until the middle of October, a very satisfactory condition in both pulse and temperature was maintained.

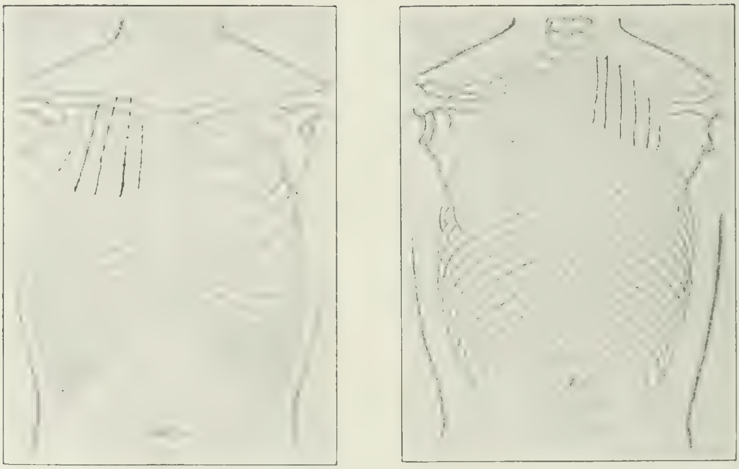
Regarding the temperature it must be said that at no time was there any rise above the normal for more than a few days at a time, after the patient was put to bed. In regard to the temperature I would further like to call attention to the menstrual wave. An examination of the charts throughout will show that, for the most part, the temperature as a whole, was about one-half degree higher during some portion of the two weeks preceding menstruation than it was during the two weeks following. This rise, as I have explained elsewhere (Vol. I, page 195), is due to the vasomotor stimulation by the internal secretion produced by the ovary during the premenstrual period.

It will further be noticed that her weight on entering the institution was 123 pounds. At the beginning of the third month, July 5th, which was the first time that she was allowed to be up long enough to be weighed, she still weighed 123 pounds. Thus, she had gained no weight during this period. She had, however, secured a general stability of temperature and pulse, a general relief from nervous irritability, and a freedom from all other symptoms. A gradual increase in weight then took place. By the end of July she had reached 128 pounds. Her weight increased up to 130 pounds and then dropped a little later. By the 10th of October she weighed 134½ pounds.

From this time on there was a disturbance noted in pulse and temperature. Neither was quite as regular as before. The patient also lost several pounds in weight. This was due to the fact that we were attempting to correct her scoliosis. In order to do so, she was going to Los Angeles once or twice a week to see an orthopedist; and, at the same time, she was wearing a brace. The effect of this can be seen readily. She became more irritable, she lost in weight, and showed a generally increased nerve irritation. It was a mistake to undertake treatment of this kind at this time. This patient should have had a complete rest during the entire period that she was in the institution. Had she obtained this she would have left the institution after her stay of a little more than eight months with a much more stable nervous system than she had acquired; at the same time, when she left, she went away in a splendid condition. She has continued her orthopedic treatment during the past year, and her efficiency is very much above what it formerly was, or what we had even hoped that it might be. This patient should eventually be restored to a very satisfactory degree of efficiency, although it has taken two years of time to bring her thus far. She illustrates graphically the result of ten years' irritation from the tubercle bacillus.

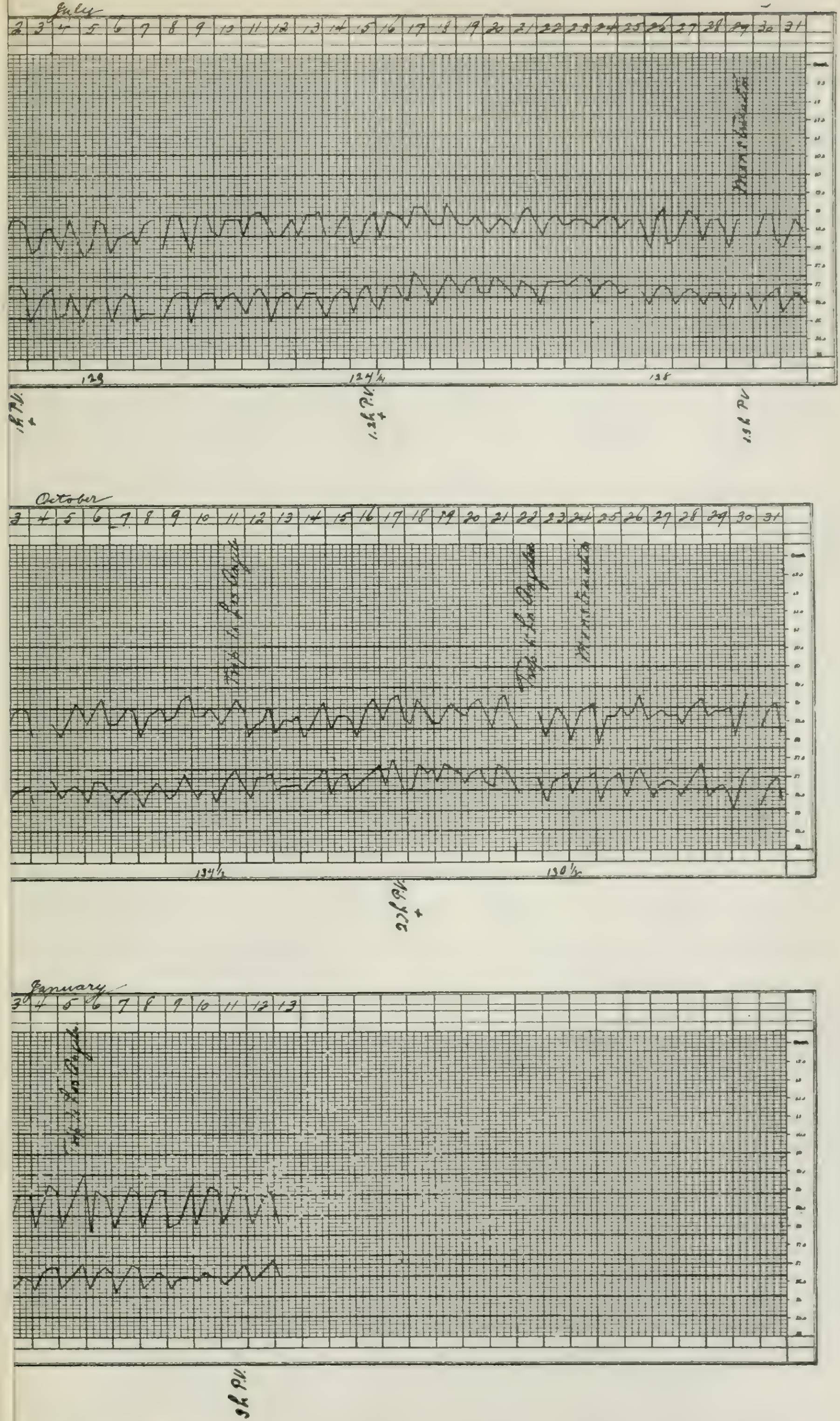
In the employment of tuberculin in this case, I did not push the dosage as fast as I usually do. This was on account of the fact that the patient was markedly nervous. It will be noticed that instead of increasing from .0001 mg. to .001 mg. P.V., I gave her .0005 and then .001 mg., then .005 mg., then .007 mg., then .009 mg., and then .01 mg. Under ordinary circumstances, in a case with no more activity than she manifested, I would have attained a dosage of .01 P.V. within thirty days. After I reached .01 mg. with her I went very slowly. Everything was going satisfactorily. The stimulation seemed to be sufficient and the response satisfactory, so I continued with this preparation at intervals of two weeks until the end of treatment. P.V. is made from a very virulent culture of tubercle bacilli; and, consequently, cannot be given in as large doses as many other preparations.

The Result of Treatment.—As a result of treatment this patient secured an arrestment of her tuberculous process; a beginning of the correction of a marked nervous instability, and had her efficiency restored to a comparatively high degree.



A *B*

Fig. 142.—Charts of chest, Case 2668.



pulse; lower curve, temperature.

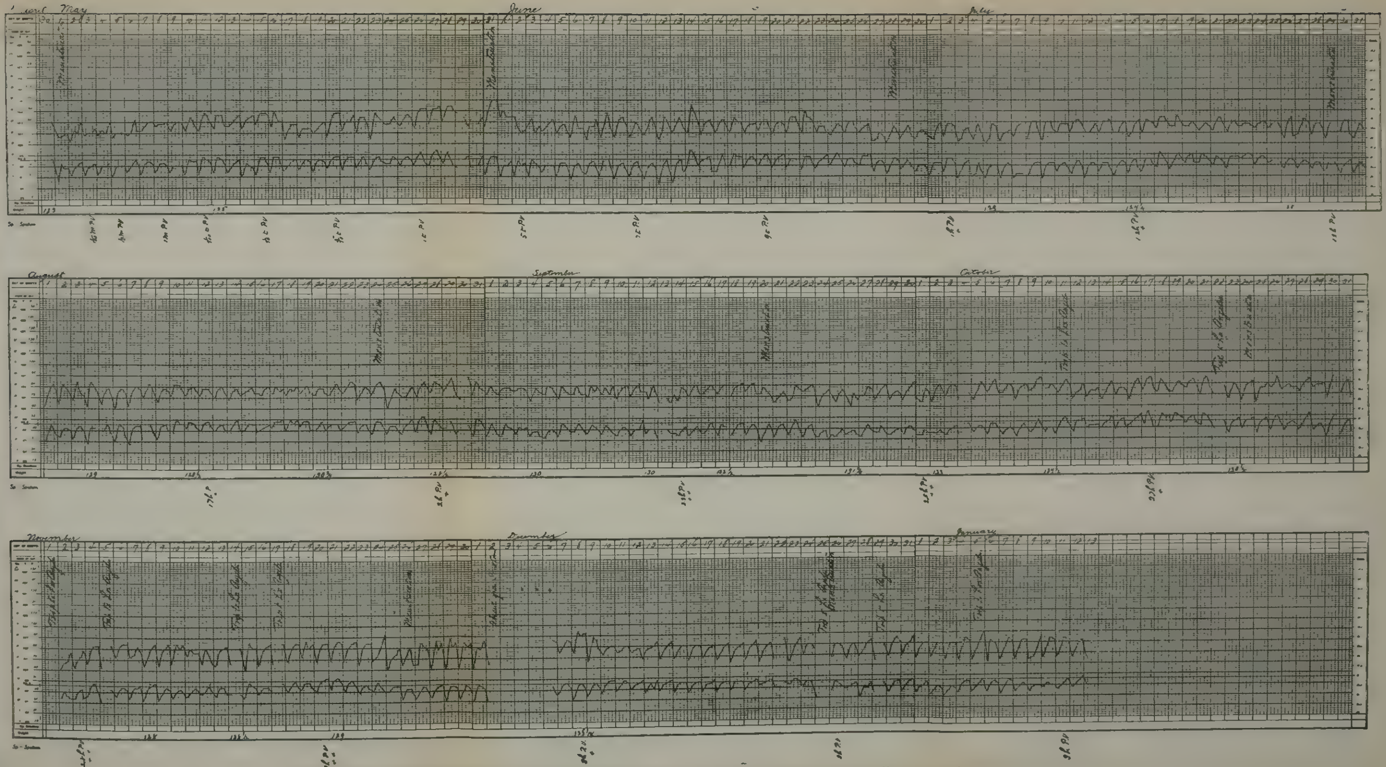


Fig. 143.—Charts showing temperature and pulse curves, with appended clinical notes and doses of tuberculin, Case 2668. Upper curve, pulse; lower curve, temperature.

Laboratory Examination at Termination of Treatment.—

Sputum:	Date	Dec. 4, 1915
	Quantity	None
Urine:	Date	Dec. 3, 1915
	Quantity (24 hrs.)	2150
	Serum albumin	negative
	Serum globulin	negative
	Sugar	negative
	Diazo	negative
	Indican	normal
	Specific gravity	1016

CASE 2635.

MODERATELY ADVANCED: SLIGHT CASEATION; NO COMPLICATIONS; ARRESTED. OBSERVED FROM AUGUST 23, 1914, TO MARCH 29, 1915.

In Which are Discussed: 'Pleurisy as an Early Symptom of Active Tuberculosis; the Relative Importance of Different Etiological Groups of Symptoms; Importance of Rest as a Therapeutic Measure; Reflex Muscle Spasm as a Sign of Pathological Healing; and Relative Chances of Such a Patient's Recovery.

Case 2635.—Merchant. Age 29. Entered the sanatorium August 23, 1914.

Family History.—Father, age 60, living and well. Mother died of tuberculosis when the patient was fifteen years old, after an illness of one year.

Personal History.—Patient enjoyed good health as a child. Had pertussis and measles when eight years old. Student until twenty-three. Has worked in a store since.

Tuberculous History.—Pleurisy five years ago at right base. At Christmas time, 1913, the patient had a cold from which he failed to recover quickly. Had another similar attack in March, and numerous others since. From Christmas on he suffered more or less from malaise, lack of endurance, nervous instability. Hoarseness also appeared with these colds, with some tickling in the throat, and cough. Expectoration began in May, 1914. Bacilli were found in the sputum one week prior to the time of entrance. These symptoms may be classified according to their etiology as follows:

SYMPTOMS DUE TO

Toxemia	Reflex Stimulation	Tuberculous Process *per se*
Malaise Lack of endurance Nervous instability Digestive disturbance Slight loss in weight Slight temperature	Tickling in throat Cough	Pleurisy Tuberculous bronchitis Sputum, bacillus-bearing

Examination.—General appearance good. Temperature normal. Pulse between 60 and 70. Blood pressure right 142, left 146. Sleeping well, bowels regular.

Condition of the Muscles and Subcutaneous Tissue.—The condition of the muscles and subcutaneous tissue is shown in the following table in which the — sign is used to indicate degeneration, and the + to indicate spasm. The degree of spasm and degeneration is indicated by the number of signs: one, meaning slight; two, marked; and three, very marked.

	RIGHT		LEFT	
	Degeneration	Spasm	Degeneration	Spasm
Sternocleidomastoideus	– –	+		+ +
Pectoralis	– –			+ +
Trapezius	– –			+ +
Levator anguli scapulæ	–			+ +
Rhomboidei				
Degenerated subcutaneous tissue	To third rib and spine of scapula posteriorly			
Lessened motion.			Marked	

Palpation of Total Resistance.—RIGHT.—*Anteriorly.*—Slightly increased resistance to the second rib. *Posteriorly.*—Slightly increased resistance to the spine of the scapula. LEFT.—*Anteriorly.*—Moderately increased resistance to the third rib. *Posteriorly*—Moderately increased resistance to the middle of the scapula. Borders of the heart are normal.

Suggested Diagnosis from Inspection and Palpation.—Old lesion in upper portion of the right lung, with slight activity extending from the apex to the second rib anteriorly, and the spine of the scapula posteriorly. A more recent lesion in the upper part of the left lung extending to the third rib anteriorly and the middle of the scapula posteriorly.

Percussion.—RIGHT.—*Anteriorly.*—Slight impairment to the second rib. *Posteriorly.*—Slight impairment to the spine of the scapula. LEFT.—*Anteriorly.*—Moderate dullness to the third rib. *Posteriorly.*—Moderate dullness to the middle of the scapula.

Auscultation.—RIGHT.—*Anteriorly.*—Slightly rough harsh inspiration, with harsh prolonged expiration to the second rib. *Posteriorly.*—Same to the spine of the scapula. LEFT.—*Anteri-*

orly.—Rough harsh inspiration with prolonged expiration to the third rib with moderate numbers of medium râles. *Posteriorly.*—Rough harsh inspiration with prolonged expiration and weak breath sounds to the middle of the scapula. A few indistinct medium râles were heard on coughing above the spine of the scapula.

Laboratory Report.—

Sputum:	Date	Aug. 24, 1914
	Quantity	33 c.c.
	Bacilli	10 to the field
Urine:	Quantity	3150 c.c.
	Albumin	negative
	Sugar	negative
	Diazo	negative
	Indican	normal
	S. G.	1009
Blood:	Hemoglobin	90 per cent
	Leucocytes	7900

Von Pirquet Tuberculin Test.—Prompt reaction to 100 per cent Koch's Old Tuberculin, reaching its maximum 1½ cm. in twelve hours; very marked in twenty-four hours, and fading in forty-eight hours.

Diagnosis.—Old focus, with slight activity in upper portion of right lung. New extension, with the beginning of necrosis, occupying the upper two-thirds of the upper lobe, and the apex of the lower lobe of the left lung. The character of the lesion may be inferred from Fig. 144, at end of description.

Prognosis.—Under ordinary circumstances, the probabilities are that the disease would have continued to spread and in a short time the patient would have presented large foci of softening and excavation; but under rest and proper treatment his chances of arrestment were good.

Analysis of the Case.—This patient emphasizes the importance of pleurisy as an early symptom of pulmonary tuberculosis. Five years prior to the time that he manifested his clinical symptoms he had pleurisy at the right base. Pleurisy, as I have insisted in other places, is tuberculosis of the pleura, and shows that there is an open focus somewhere in the body from which bacilli are escaping. It is a metastasis from an active lesion and means active tuberculosis just as much as it would were it deep in the lung, in the kidney, in the meninges, or any other organ. The fact that tuberculous pleurisy is not immediately followed by active disease leads us to minimize its importance. Every patient who shows pleurisy of tuberculous origin,—and most of them are of that type, whether they are accompanied by effusion or not—should be given the same advice as though we had found an active tuberculous lesion elsewhere. The next important feature in diagnosis in this case was, repeated and protracted colds,—tuberculous bronchitis,—which started at Christmas time. Eight months prior to the time that the patient entered the sanatorium the protracted colds were due to active tuberculosis in the lung. This patient, prior to the time that he entered the sanatorium, had three symptoms which I class as belonging to the tuberculous process *per se*,—pleurisy, frequent and protracted colds, and sputum. This patient had lost only a few pounds in weight. When entering the institution he was within two pounds of his normal. On numerous occasions he had shown symptoms produced by the toxins, such as malaise, lack of endurance, nervous instability, and slight temperature. Those of reflex origin, such as hoarseness, tickling in the throat, and cough were also present; so this patient had symptoms of each of the important groups, which should have made the diagnosis quite definite. The diagnosis of pulmonary tuberculosis was quite clear in the case even without physical findings.

In forming our opinion of the value of symptoms, we must not forget that those belonging to the tuberculous process *per se* are the most valuable because each of them means active tuberculosis, without question. Those due to toxemia can be produced by other forms of toxemia; but, where they are associated with others of the reflex group, and that group belonging to the tuberculous process *per se*, there can be no question. The reflex symptoms in this case all pointed to the larynx; but the fact that there were symptoms of the other groups present, showed definitely that the larynx was probably only reflexly affected. The fact that his "colds" were repeated, that he had one attack of bronchitis after another, is largely explained by the existence of the lesion found at the time of examination. During this period the disease was spreading, and the amount of necrosis and caseation was increasing, and the patient's chances of cure were gradually disappearing.

Course of the Disease During Treatment.—The temperature and pulse records of this case are shown in Fig. 145. The patient entered the institution and was put to bed at once. I wish to insist upon the importance of rest in all patients who are suffering, or who have been recently suffering, from active symptoms of tuberculosis. This patient was within two pounds of his normal weight and weighed 170 at the time of entering the institution. It might be thought that rest under such circumstances would not be necessary, particularly since he was not showing a rise of temperature and increased pulse rate; but experience shows that rest is one of the most important methods of treating these cases. Had he continued walking around, and exerting himself, the probabilities are that there would have been further extension with breaking down before healing would have occurred, if it occurred at all. (See chart at end of description.)

It is also essential in treating patients who are in the more favorable stage for cure, and in whom the disease has not yet made marked inroads upon the general physical strength, to employ some method by which one can secure their cooperation. If the physician can impress upon the patient the fact that the disease is so serious that it is necessary for him to follow a carefully outlined program, a very important psychical influence has been exerted, which will greatly aid both the physician and patient in carrying out the treatment.

In the eight months prior to the time that this patient entered the institution his disease had probably extended from a small beginning in the left lung, to an involvement equal to nearly half of his lung area on the left side. This shows the danger that was threatening him. By putting the patient at rest in the open air, giving him good food, without stuffing, and giving him the hope and encouragement of making a recovery, the conditions were ideal for building up his resisting power. He was given sun baths, cold morning sponges, and tuberculin.

While there was no particular rise in temperature, yet careful observation will show that there were slight waves in the temperature during the first three months of his stay in the institution,—one appearing the latter part of the first month; the second, the latter part of the second month; and the third, about the middle of the third month. Then, following this, the temperature curve became more steady and continued so during his stay in the institution. The only rise after this was noticed in the middle of March, but that was due to a sudden spell of warm weather.

Aside from the measures which I have mentioned for the building up of the patient's resistance, this patient was put upon tuberculin at once, as will be seen, and was kept on it during his entire stay in the institution. The beginning doses were small, but the amount was progressively increased, the interval between doses was gradually lengthened, the intervals varied from two days in the beginning to two weeks at the last.

This type of case is often most difficult to handle successfully particularly because of the fact that the patient looks and feels well. It is, at times, extremely difficult to impress upon the patient the importance of rest and care, when he feels so well and shows so few symptoms. The laboratory report, however, showed the continuance of the presence of bacilli during the first six months of the patient's stay in the institution. After that they disappeared. He had very little cough. There was a gradual decrease in the quantity of the sputum, from 30 c.c. per day to practically none in six months.

If one follows the charts in this case he will see that they are all practically the same after the third month, the temperature remaining, for the most part, between 97° and 98°. The pulse was continuously between 60 and 70. Patients who show a pulse of this character, as a rule, are slightly vagotonic (Vol. I, page 200); and, for the most part, offer a good prognosis.

This patient was kept in bed during the first two months. At the end of the second month he was allowed up for two or three hours a day and was, at that time, started upon sun baths, which were continued during his entire stay in the institution, which terminated on the 29th day of March, 1915.

Termination of the Case.—This patient secured an arrestment of his trouble, leaving the sanatorium after a stay of seven months, with normal temperature, normal pulse, no sputum, and free from any symptom of the disease. The apical muscles, especially the sternocleidomastoideus, trapezius, and levator anguli scapulae on the left side, however, showed that there was still a slight inflammation in the lung. This is extremely important as a sign and may be used as a method of determining whether or not an infiltration has gone on to the formation of scar tissue. All of the original symptoms belonging to each of the groups mentioned above had disappeared during the early months of treatment; but that does not mean that the patient was well. One of the most important lessons to learn is that it takes time for healing. No patient gets well in three or four months' time, nor in six months' time. The bacillus-bearing sputum had disappeared in the early part of the sixth month; but, from the reflex motor change in the apical muscles, it was evident that a pathological healing had not taken place at the time of the patient's discharge from the institution.

The patient returned again for examination and for two months' further treatment in September, 1915. We found him still free from symptoms and the spasm of the muscles had almost wholly disappeared. Lagging of the chest wall was also absent. From these facts we are led to infer that the infiltration had largely been transformed to scar tissue and that the inflammatory condition had almost wholly disappeared.

Laboratory Examination at Termination of Treatment.—

Sputum:	Date	Feb. 19, 1915
	Quantity (24 hrs.)	1 c.c.
	Bacilli	negative
Urine:	Date	March 22, 1915
	Quantity (24 hrs.)	2850
	Albumin	negative
	Sugar	negative
	Diazo	negative
	Indican	slightly increased
	Specific gravity	1011

Comment.—This patient illustrates the treatment of one of the most hopeful of the moderately advanced cases. A careless let-alone policy would have undoubtedly led to disaster in this case; while a careful aggressive course, impressing the patient with the seriousness of his trouble, and securing his active and hearty cooperation, led to an arrestment, which has gone on to an apparent healing. It is difficult to determine what such a patient's chances of cure are; but under a let-alone half-hearted policy, they would probably have been less than 50 per cent.

Such patients as this usually receive the professional, as well

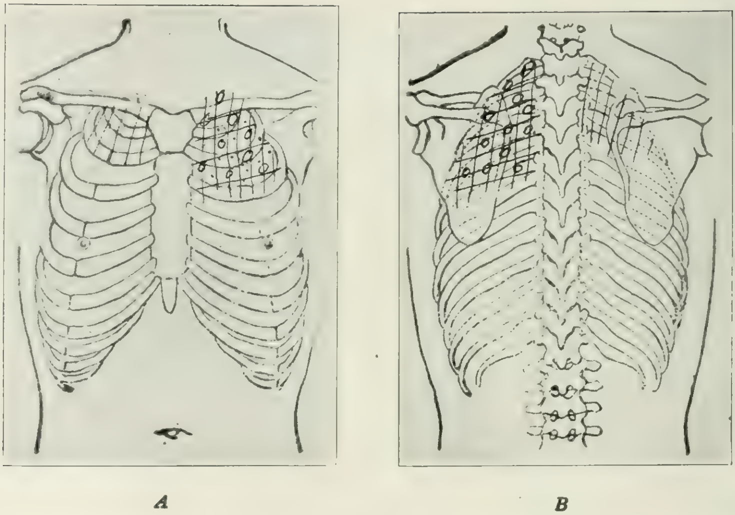
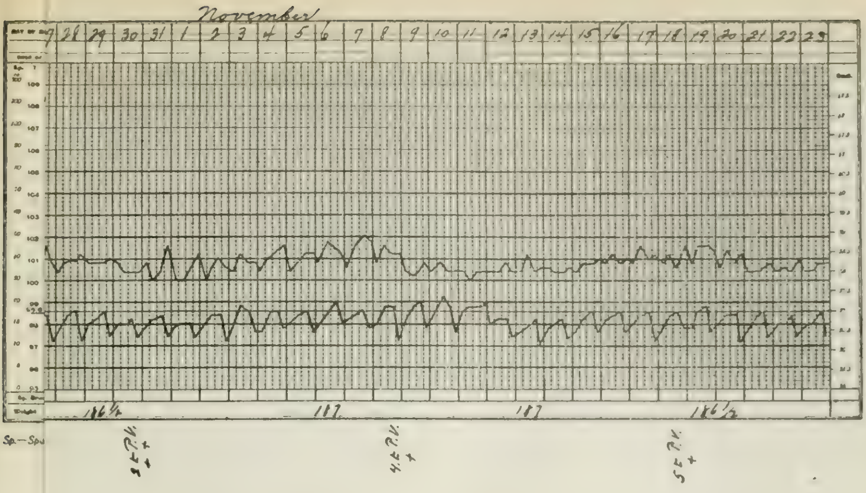
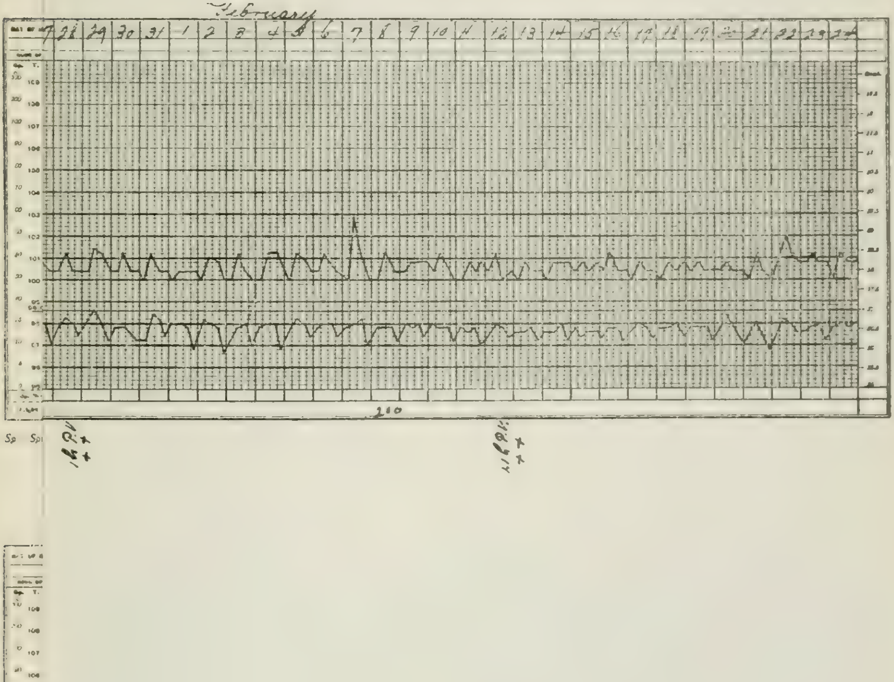


Fig. 144.—Charts of chest, Case 2635.





wer curve, temperature.

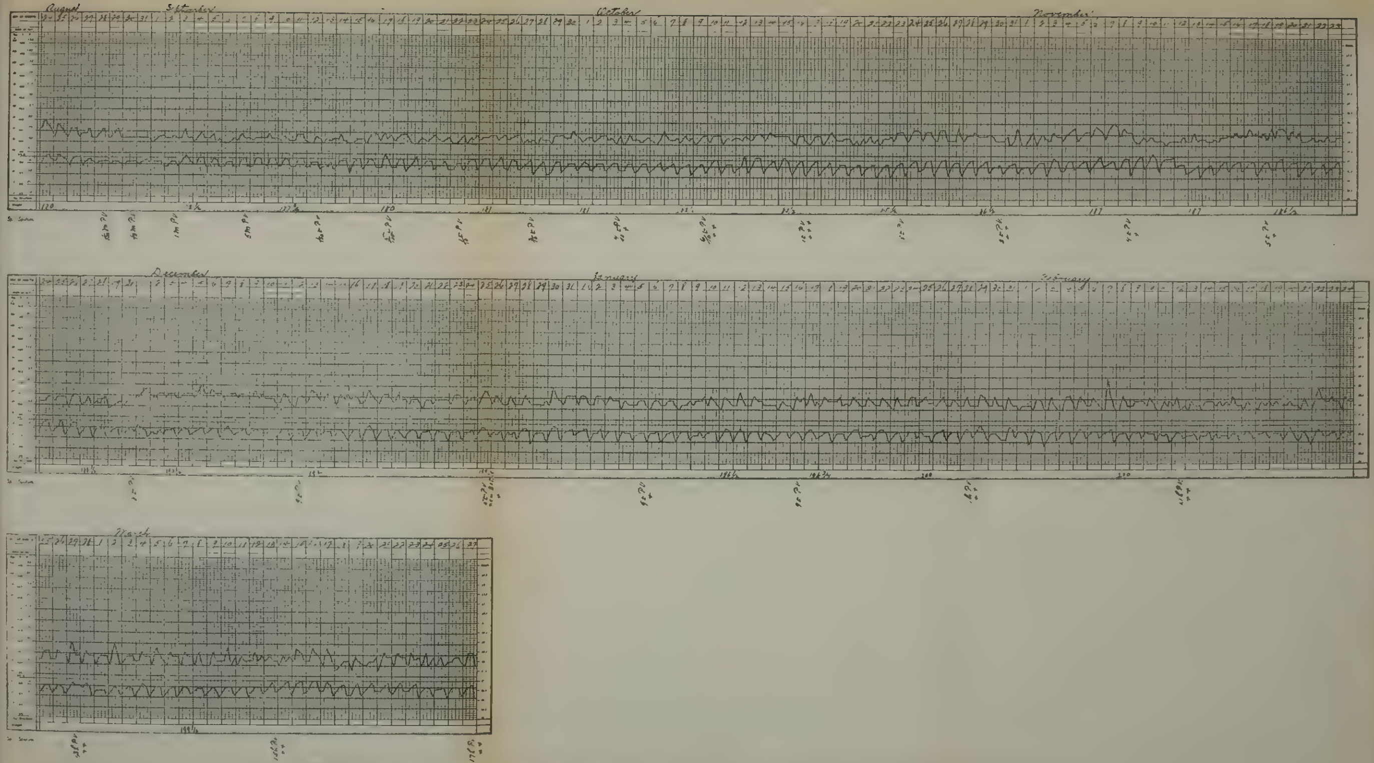


Fig 115.—Charts showing temperature and pulse curves, with weights of patient and doses of tuberculin, Case 2635. Upper curve, pulse; lower curve, temperature.

as the lay opinion that they are not sick enough to enter sanatoria or to undergo a strict program for cure. The result of such advice is disastrous in most instances. The chances of recovery of a patient in this condition are no better than those of a patient suffering from acute pneumonia on the 5th or 6th day; one in the first week of typhoid, or one who is suffering from an acute attack of appendicitis. If tuberculosis is to be taken from the class of hopeless diseases these patients must receive the same careful treatment as would be afforded them were they ill of other serious diseases.

CASE 2514.

ILLUSTRATING ACUTE RAPIDLY FORMING FIBROSIS WITH LIMITED NECROSIS, GOING ON TO ARRESTMENT. OBSERVED FROM JULY 5, 1914, TO SEPTEMBER 11, 1915.

A Discussion of: The Relation of Infection to the Early Symptoms of Active Tuberculosis; the Method of Applying Rest and Adjusting Exercise to Severe Cases; the Pneumonic Type of Temperature; Change to Rapid Formation of Fibrous Tissue; Effect of Tuberculin in Toxic Cases with Fever; Heliotherapy; Periods of Activity Characteristic of Tuberculosis, and Their Relationship to the Progress of the Disease; the Pulse Curves as Influenced by Depressive Emotions; and the Relationship Between Inflammation in the Lung and Slow Pulse.

Case 2514.—Bank Clerk.—Age 23.—Entered the sanatorium July 5, 1914.

Family History.—Father, living and well, age 55. Mother, living and well, age 48.

Personal History.—The patient was a student until twenty years of age. Clerked in bank from that time until present illness and had fairly good health. Had measles, pertussus, and severe enterocolitis when a child. Is said to have had cough for one year at the time of the enterocolitis, beginning at the age of three years.

Tuberculous History.—Patient contracted "severe cold" in April, 1914, which was accompanied by much prostration, with fever and sweats, coughing, and some expectoration. The patient remained away from work for a short time and then returned again. Six weeks later had a moderate hemorrhage. Lost about ten pounds in weight, from 115 to 105 pounds.

The symptoms in this case could be tabulated according to their etiology, as follows;

SYMPTOMS DUE TO

Toxemia	Reflex Stimulation	Tuberculous Process *per se*
Malaise Lack of endurance Nervous instability Increased pulse Loss of weight Sweats Fever	Cough	Hemorrhage Sputum Tuberculous bronchitis

Examination.—The patient's general appearance was good. Temperature was 102° to 104°. Pulse 100. Blood pressure on the right 106, and on the left 104.

Condition of the Muscles and Subcutaneous Tissue.—The condition of the muscles and subcutaneous tissue is shown in the following table in which the — sign is used to indicate degeneration, and the + to indicate spasm. The degree of spasm and degeneration is indicated by the number of signs; one meaning slight; two marked, and three very marked.

	RIGHT		LEFT	
	Degeneration	Spasm	Degeneration	Spasm
Sternocleidomastoideus	—	+ +		+ +
Pectoralis	—	+ +		+ + (upper fibers)
Trapezius	—	+ +		+ +
Levator anguli scapulæ	—	+ +		+ +
Rhomboidei				
Degenerated subcutaneous tissue	To fourth rib and spine of scapula posteriorly			
Lessened motion.	Marked		Slight	

Palpation of Total Resistance.—RIGHT.—*Anteriorly.*—Marked increased resistance over entire right side, particularly above the fourth rib. *Posteriorly.*—Increased resistance to the lower angle of the scapula. LEFT.—Slightly increased resistance over the apex and an increased tension with decreased resistance over the remaining portion of the left lung, indicative of emphysema.

Suggested Diagnosis From Inspection and Palpation.—From the fact that there is lessened motion on both sides of the chest, I would infer that both sides are the seat of infiltration. From the fact that the right is more marked than the left, I would infer that this side is either the seat of the more severe lesion or that pleural adhesions are present. From the fact that the sternocleidomastoideus, pectoralis, trapezius and levator anguli scapulæ, and the subcutaneous tissue and skin covering them on the right side are degenerated, I would infer that the right lung has been the seat of an old chronic infiltration. From the fact that these same muscles are in marked spasm, I would infer that at the present time this old focus is the seat of renewed activity. From the fact that the sternocleidomastoideus, pectoralis, trapezius and levator anguli scapulæ on the left are in marked spasm, and that there is no degeneration either of the muscles or the soft tissues covering them, I would infer that there is a new lesion at the left apex which at the present time is active.

Percussion.—Percussion substantiated the findings on palpation. RIGHT.—*Anteriorly.*—Moderate dullness to the fourth rib. *Posteriorly.*—Moderate dullness to the lower angle of the scapula, and slight impairment below these levels to the base. LEFT.—*Anteriorly.*—Slight impairment of the note over the left apex to the second rib. Posteriorly.—Slight impairment of the note to the spine of the scapula, with hyperresonance over the remaining portion of the lung.

The heart was in normal position.

Auscultation.—RIGHT.—*Anteriorly.*—Marked rough harsh inspiration with rough harsh prolonged expiration and numerous medium râles to the fourth rib. *Posteriorly.*—Same to lower angle of scapula, and slightly rough harsh weakened inspiration to the base. LEFT.—Slightly rough inspiration at the left apex and slightly harsh inspiration with prolonged expiration over the entire left lung.

Tuberculin Test.—Maximum reaction in twelve hours.

Laboratory Examination.—

Sputum:	Date	July 6, 1914
	Quantity (24 hrs.)	50 c.c.
	Bacilli, per field	2
Urine:	Quantity	1500 c.c.
	Albumin	negative
	Diazo	negative
	Sugar	negative
	Indican	30
	S. G.	1018
Blood:	Hemoglobin	85
	Lymphocytes	7500

Diagnosis.—Disseminated tuberculosis involving the entire right lung, the upper half being most severely infected. The process is of fibro-ulcerative type; the fibroid form being primary and having recently taken upon itself the ulcerative type. Severe degree of collateral inflammation. Slight infiltration at left apex due to new involvement. The condition in this chest is shown in Fig. 146 at end of description.

Prognosis.—The prognosis in this case seemed grave and decidedly unfavorable.

Analysis of the Case.—From the standpoint of diagnosis this case represents a class which is not unusual, where the disease breaks down suddenly, taking upon itself grave symptoms without previous warning. This patient had never been very strong. The infection had extended to the apices sometime prior to this break down, but, from this history, we are unable to tell when this occurred, because he gives no symptoms. At no time can we point to definite symptoms of tuberculosis prior to the outbreak in April, 1914. This history of suffering from stomach disturbance when a year and a half old, accompanied by cough when three years of age, might point to an infection of the bronchial glands. During that time the patient was not strong, did not grow and develop normally, just the conditions that we would expect to be present if a bronchial gland infection were active. From that time until the onset of symptoms in 1914, one would have been at a loss to point to any clinical history of active tuberculosis, in spite of the fact that the disease had spread to the right lung prior to this time. The earliest reported symptoms referable to active tuberculosis in this patient were those of considerable severity;—severe cold with cough. Whether it was primarily an expression of renewed activity in an old focus due to the multiplication of bacilli in old areas of infection, or an acute respiratory infection which started the activity we do not know. As is usual in either case, however, these symptoms improved, and the patient returned to work. After a period of two months more, however, he was seized with hemorrhage and a renewal of his former symptoms, with increased toxemia, caseation and cavity formation.

Treatment.—This patient was put to bed and not allowed to get up except for changing the bed. He was allowed to lengthen the time of being up when his temperature approached the normal during the fourth month. Getting a patient up after a serious illness of this kind requires caution. At first this patient was allowed to sit up ten minutes a day; and this was increased ten minutes each day until forty minutes was reached. He was then allowed thirty minutes in the morning and twenty in the afternoon. This amount of exercise then was not increased for a week. The patient was then allowed to walk in the room. We then again increased by ten minutes a day until the patient was up three hours, which was continued until the fifth month. Then the patient was allowed to walk in the corridor; but he was not allowed to be up and out of his room except for a short walk in the corridor until the sixth month. In explanation of this caution, I wish to emphasize the fact that the disappearance of toxic symptoms does not mean the disappearance of active pathological inflammation. Even after normal temperature has been attained, overexertion is prone to produce further activity.

The patient was given a cool sponge each day and a cleansing bath twice a week; three regular meals a day, tuberculin; and, later, heliotherapy. I always urge such patients to eat a hearty breakfast. This is the time when the stomach has rested for the longest period and the patient is free from fever. A hearty meal eaten at this time is digested and cared for before the afternoon rise comes. The patient can then eat a lighter lunch and a hearty meal again at night when the temperature is on the decline.

Course of Disease During Treatment.—The temperature and pulse records of this case are shown in Fig. 147. At the time of his entry into the sanatorium, the lesion in his lung was widespread. The entire right lung was involved and there was slight involvement in the upper part of the left. While the infection in the right lung was widespread, the amount of necrosis present was confined largely to the upper lobe and apex of the lower lobe. The picture was that of widespread dissemination with rather rapid destruction. As will be noted, the temperature at the time of entering the sanatorium and during the first three months' stay was that of a pneumonic process. It was indicative of a continuous high degree of toxemia. The temperature at first was above 100° in the morning, reaching 102° or even

103° in the afternoon. After a period of three or four weeks the temperature dropped to 99° in the morning, the afternoon temperature still reaching 100°, and, occasionally 101°. From that time there was a decline, so that by the end of the third month the morning temperature was down to 98°, and the afternoon temperature only a little above 99°. A temperature such as this is characteristic of a pneumonic condition. This patient had temperature every hour of the day. There was no time when he was free. During such conditions, as a rule, not only is there necrosis taking place, but there is a widespread collateral inflammation. The great danger in this case was that a widespread necrosis with cavity formation would result, as well as that of further metastases. Fortunately, for the patient, the amount of necrosis limited itself. Fibrosis began to predominate, and, by the end of the third month, marked improvement was shown on physical examination, as well as in symptoms. The râles in the lung began to disappear and the whole picture assumed a less virulent aspect. The sputum had decreased to 5 c.c. per day. At this time contraction became very apparent and the heart began to shift to the right.

During the fifth month the temperature reached normal, and remained so from that time on. By the end of the sixth month the heart had shifted considerably to the right, although it did not move freely, probably on account of pleuropericardial adhesions at the apex. The right lung was very much reduced in size by contraction, and the diaphragm on the right side was displaced upward. The left lung had taken upon itself a marked degree of emphysema and the diaphragm was pushed lower than normal.

Why this infection turned from that of a condition of widespread threatened necrosis to that of the milder form of fibrosis and marked increase of connective tissue cannot be told; but, it is a change which we occasionally see, and one which encourages us to have confidence in a possible chance for life, even though the infection seems so severe that the prognosis appears hopeless.

He was treated with "J.K." for the first two months and then with bovine tuberculin. At the time tuberculin was begun during the latter part of September, his temperature was running from 98.6° in the morning to 100°. If there can be any change attributed directly to the use of tuberculin, it was a more rapid decline in his temperature, also a very satisfactory decline in the pulse rate. This was especially noticeable after a dose of some size was attained.

A focal stimulation might irritate the ends of the pulmonary vagus sufficiently to cause the reflex slowing of the pulse, the same as is seen in many cases as a result of the inflammation itself and illustrated in many of the charts shown throughout this work, particularly in Chapter VII, Volume I. The same is also well shown in the slow pulse as compared with the temperature during the first month in the appended chart of this case.

Following tuberculin given on the 27th of October, there was a marked decrease of several beats in the pulse rate, a decrease which continued. At the beginning of his fifth month it was found to be 80 in the morning and less than 100 during the day.

On the 19th of November the patient began to sit up a little longer. We allowed him to increase his time at the rate of ten minutes per day until he reached three hours. There was a slight tendency for his pulse to increase after he began to sit up for two or three hours a day, but this soon adjusted itself and by the beginning of the sixth month, his pulse was running steadily from 80 to 95, and later 80 to 90, in spite of the patient sitting up four or five hours a day and doing some walking.

In the middle of November the patient was started upon heliotherapy, at first the chest being exposed for a few minutes each day. Larger surfaces were also gradually exposed, and after a little time the patient was taking a one hour sun bath each day. Beginning the latter part of December, aside from his general sun bath, he was given a concentrated sun bath, using the large mirrors mentioned in the chapter on heliotherapy.

The condition in the lung made very satisfactory progress. There was only now and then a slight rise in temperature. During January, February and March, and the early part of April, it will be noticed that the patient had a wave of higher temperature, and increased pulse rate. This was repeated again during the latter part of May and the early part of June, the middle of July, the early part of August, and the latter part of August.

These waves were significant. They were the usual waves of activity that appear during a chronic course of tuberculosis which is not wholly quiescent. This patient did not have symptoms of toxemia continuousuly; but these waves indicate that every now and then, at more or less regular intervals of about two weeks, the process in the lung became a little more active, more toxins were thrown into the blood stream, and the syndrome of toxemia manifested itself. When one sees elevations of temperature such as these he knows almost with certainty, what other symptoms are present. This elevation of temperature is but one symptom in the syndrome of toxemia. Each of these rises of temperature is associated with general nerve cell stimulation which means nervous irritability, often depression, malaise, insomnia at times,—not regularly, digestive disturbances and rapid heart. These patients nearly always complain of the stomach and bowels. They have indigestion and constipation. They say they are "bilious." There is a stoppage of digestion, probably with resultant absorption of toxic material from the intestinal tract. Clinicians are very apt to accept this as the diagnosis; but "biliousness," like la grippe, rarely becomes chronic; and, when a patient suffering from tuberculosis frequently has either of these symptoms, we must consider it as being due to activity in the pulmonary process, rather than to these named complications.

I wish to emphasize the fact that these indications of increased activity are wholly consistent with favorable progress. They do not mean that the patient is not doing well, and that his disease is not healing. Tuberculosis heals through inflammation. Many areas in the lung cannot get well until they have gone through these inflammatory processes. The bacilli, for the time being, have the upper hand and multiply. As they multiply, there must be some outlet for the toxins produced. If the tissues become necrotic they are apt to caseate and ulcerate, although, at times, even after necrosis and caseation have taken place, organization may take place without ulceration resulting. It is important for those who are treating tuberculosis to correlate the symptoms and the pathology and to bear in mind that when the patient is throwing off necrotic material he is hastening healing. After the process has gone beyond the early irritation of the pulmonary cells, then necrosis is apt to occur, and in many of these instances it should be welcome, because it is getting rid of infectious material, which would be a further source of danger.

As long as the general condition of the patient is satisfactory, as long as he can pick up between attacks of softening, and regain his former condition, and keep his nutritional balance, he is doing thoroughly satisfactorily; but this cannot always be done. Now and then these periods of activity will come so frequently that the patient does not react from one until another is upon him. Such circumstances produce a continuous type of temperature because there are toxins escaping continuously into the blood stream.

When such a condition is present we speak of it as being a pneumonic process; in fact, any tuberculous inflammation is a pneumonic process,—an inflammation of lung tissue; but we have learned to recognize a pneumonia as being a disease which produces a continuous temperature; so, when there is an area of lung tissue sufficiently large, involved; and when the degree of activity is sufficiently great to produce a continuous discharge of toxins into the blood stream; we speak of it as being a pneumonic process. It can be seen that this is much more serious than the type of temperature shown during the last months of treatment. This patient showed a pneumonic type of temperature during the first few months, and had that continued during the entire time the outcome would have been questionable; in fact, it would have eventually proved fatal, because no individual can stand a high degree of toxemia with its stimulation of the sympathetic nervous system and the inhibiting effect upon all the vital forces which result from it, over a long period of time, without serious, and usually fatal, results.

This patient's pulse curve needs some explanation. It will be noted that the pulse curve, like that of the temperature, went more or less in waves. It will also be noted that there was rather a wide diurnal variation in the pulse during many of the months. This diurnal variation began to be greater about the latter part of February. This was coincident with a greater amount of exercise. The curves, for the most part, follow rather closely the slight elevations in the temperature curve, which have been previously discussed. This boy was very nervous. He was introspective and inclined to be impatient about getting well. He seemed to labor under a constant fear lest he would not get well. This was accountable, in my estimation, for quite a little bit of the variability in pulse rate.

During the latter part of August and the early part of September, the diurnal variation in both temperature and pulse decreased. This was associated with more rest, and also with an improved frame of mind. The patient became more optimistic and relieved the nervous system of the extra burden due to depression. If one will follow his tuberculous patients carefully he will soon learn what a tremendous influence the depressing emotions exert. They influence both temperature and pulse; they decrease digestive power; have a tendency to produce insomnia; and, from this, we may infer, that they have a general inhibiting influence upon the vital forces.

It is especially desirable to note the July and August charts, as showing the effect of the pulmonary process in irritating the pulmonary vagus, and causing a reflex depressor effect upon the heart. It will be noted that, on entrance, the patient was running a temperature of 102°. On the day of entrance it reached 104°. Again, about the middle of the month it went higher, and exceeded 102° during each day. During this time the pulse was ranging, for the most part, between 80 and 90, or between 90 and 100. Beginning on the 23rd day of July, the temperature dropped to 101°, and continued so until about the end of the month when it went a little higher for a week. The pulse, on the contrary, instead of dropping with the temperature, increased in frequency. The explanation of this is clear. As the inflammation in the lung began to subside, the irritation of the pulmonary ends of the vagus, was relieved,—the reflex effect upon the vagus fibers going to the heart was lessened, giving the sympathetic nerves greater power to act, and the heart assumed a more rapid rate. It will be noticed that the February temperature came below 100°, and during the third month the pulse still continued between 90 and 100. During the fifth month, when the temperature was normal, the pulse still continued between 80 and 100. During this early pneumonic period, when the toxemia was very marked, this patient should have had a much higher pulse rate, but it was prevented from rising by the reflex vagus stimulation, in which the afferent impulses were carried through the pulmonary branches of the vagus and the efferent through the cardiac branches.

This patient went on to an arrestment.

Laboratory Examination at Termination of Treatment.—

Sputum:	Date	Nov. 5, 1915
	Quantity (24 hrs.)	45 c.c.
	Sediment	7 c.c.
	Bacilli per field	1
Urine:	Date	Nov. 5, 1915
	Quantity (24 hrs.)	2200
	Albumin	negative
	Sugar	negative
	Diazo	negative
	Indican	normal
Blood:	Date	Nov. 5, 1915.
	Hb.	99
	White cells	12,800

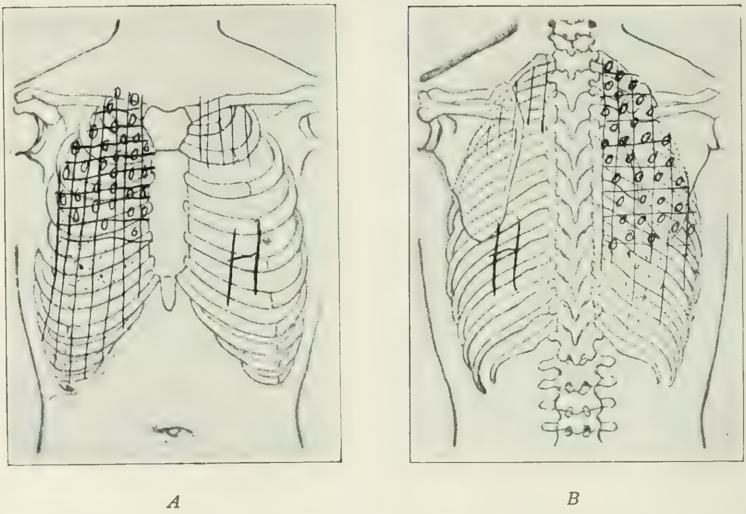


Fig. 146.—Charts of chest, Case 2514.

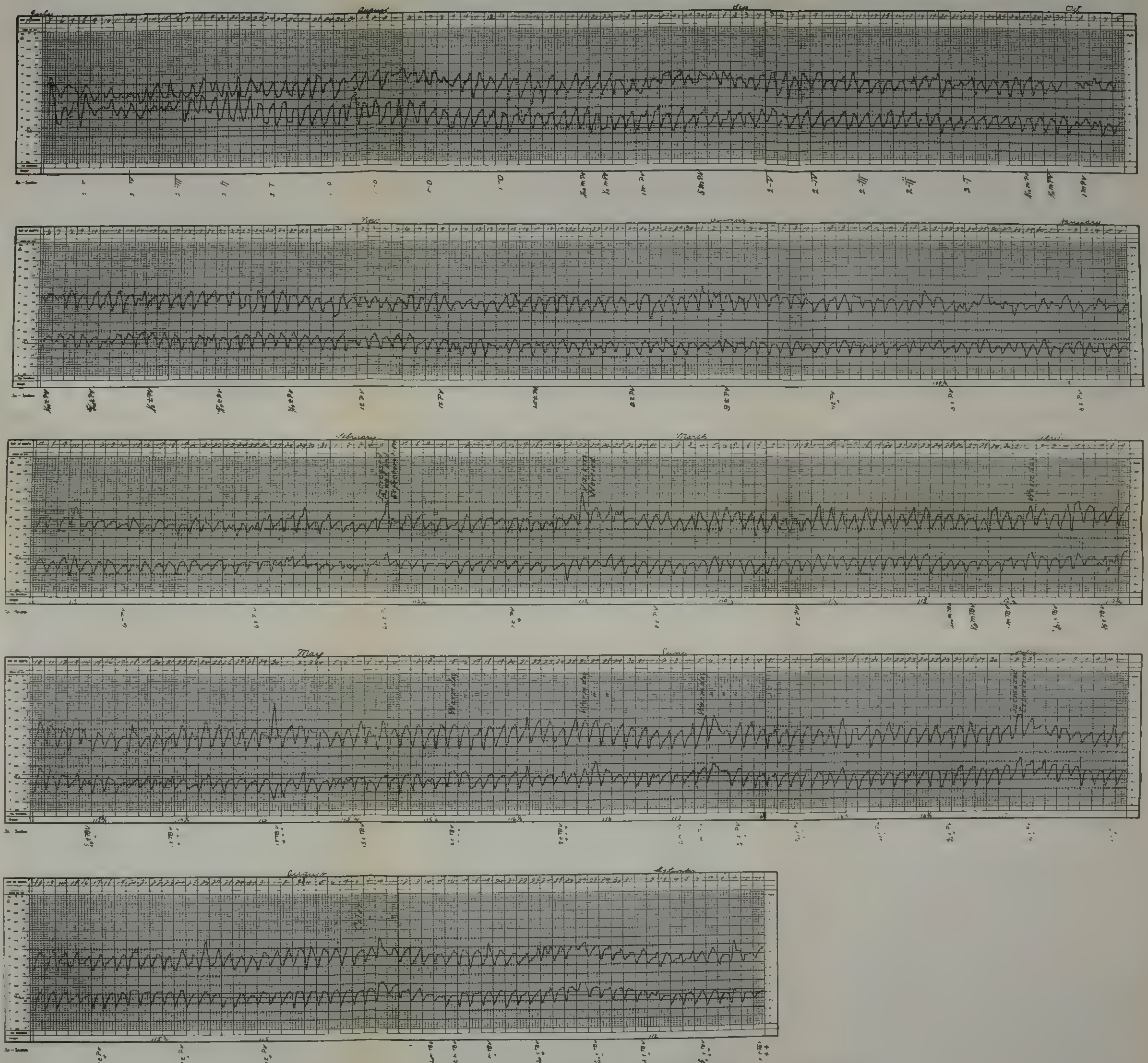


Fig. 147.—Charts showing temperature and pulse curves, with clinical notes and doses of tuberculin, Case 2514. Upper curve pulse, lower curve temperature.

CASE 2542.

CHRONIC CASE OF FIBRO-ULCERATIVE TUBERCULOSIS; PLEURISY RIGHT BASE; ACTIVE SYMPTOMS DURING TEN YEARS WITHOUT DIAGNOSIS BEING MADE; FAVORABLE PROGNOSIS; ARRESTMENT: LATER ACTIVITY WITH SPREAD OF DISEASE AND DEATH. OBSERVED FROM NOVEMBER 18, 1914, TO JUNE 16, 1915.

A Discussion of: Delayed Diagnosis; Tuberculin Treatment; Diet; Mistake of Considering the Cessation of the Toxic Symptoms and a Return to Normal Weight and Feelings as Cure: Relationship of the Three Groups of Symptoms to Healing.

Case 2542.—Housewife. Age 30. Entered the sanatorium November 18, 1914.

Family History.—Nothing of interest.

Personal History.—Patient has complained very little during life except as her tuberculous process has manifested activity from time to time. Had mumps and scarlet fever as a child, but recovered promptly.

Tuberculous History.—Patient had pleurisy for the first time when she was twenty years of age, the right side being affected; again five years prior to consulting me, during her first pregnancy, the same side being affected; and again in the fall of 1913. This last attack was accompanied by a high fever and the patient was taken to the hospital. The probabilities are that there was some effusion, although the diagnosis of effusion was not made. During the winter of 1912, the patient was pregnant with her last child. During this pregnancy she failed in strength and general health and immediately following the birth of the child had the pleurisy mentioned above. In the following winter she developed a cough without expectoration. She was so much run down in strength that she consulted several physicians all of whom told her there was nothing the matter with her lungs, although her husband insisted that there must be. She then went to the eastern coast to visit for the winter. Her strength improved and her weight increased to 145 pounds, which was ten pounds above her normal. All of the symptoms from which she had complained disappeared and she returned to her home in the west thinking that she was well.

In the fall of 1913 the same toxic symptoms returned. Hoarseness appeared, the cough became persistent and so severe that the patient would often vomit; yet, strange to say, it was not accompanied by expectoration. The patient's general strength declined and she lost a great many pounds in weight.

In the summer of 1914 she visited the mountains, thinking that that would perhaps help her, but received very little benefit from the change. She gained in weight, but her cough persisted, likewise pain in the left shoulder which was considered to be of a rheumatic nature.

The symptoms in this case could be tabulated according to their etiology, as follows:

SYMPTOMS DUE TO		
Toxemia	Reflex Stimulation	Tuberculous Process *per se*
Malaise Lack of endurance Digestive disturbance Rapid pulse Loss of weight Fever	Hoarseness Cough Pain in shoulders	Tuberculous bronchitis Pleurisy Sputum

Examination.—General appearance good. Temperature 99, pulse 94. B.P. 104 on the right, 99 on the left. Slight dyspnea on exertion.

	RIGHT		LEFT	
	Degeneration	Spasm	Degeneration	Spasm
Sternocleidomastoideus	— —	+	—	+ +
Pectoralis	— —	+		
Trapezius	— — —	+	—	+ +
Levator anguli scapulæ	— — —	+	—	+ +
Rhomboidei				
Degenerated subcutaneous tissue	Very marked to fourth rib anteriorly, and to base posteriorly	———	Slight to third rib and spine of scapula posteriorly	
Lessened motion.	Marked		More marked	

Condition of the Muscles and Subcutaneous Tissue.—The condition of the muscles and subcutaneous tissue is shown in the preceding table in which the — sign is used to indicate degeneration, and the + to indicate spasm. The degree of spasm and degeneration is indicated by the number of signs; one meaning slight, two marked, and three very marked.

Palpation of Total Resistance.—Left.—*Anteriorly.*—Above the second rib there was increased resistance. *Posteriorly.*—Increased resistance above the upper third of the scapula. The remaining portion of the lung showed slightly increased tension and slightly decreased resistance indicative of compensatory emphysema. The position of the heart was normal. Right.—*Anteriorly.*—The total resistance as determined by palpation revealed moderate resistance to the fourth rib. *Posteriorly.*—Moderate resistance to the lower third of the scapula, except near the apex, where there was a decided decrease in resistance to the finger, suggestive of cavity. From the lower third of the scapula to the base, the resistance was moderate and the soft tissues were doughy and inelastic, suggestive of thickened pleura.

Suggested Diagnosis from Inspection and Palpation.—From the fact that the muscles and subcutaneous tissue are both markedly degenerated over the upper portion of the right lung, which also shows increased resistance on deep palpation, we infer that this area is the seat of an inflammation, chronic in character. From the fact that the muscles are slightly in spasm, we infer that at the present time the infiltrated area is the seat of renewed activity. From the degeneration of the soft tissues over the base, we suspect thickened pleura. From the slight degeneration and marked spasms of the muscle over the upper portion of the left lung, and from the slight degeneration of the subcutaneous tissue over the muscles, we infer that there has been a chronic inflammation of slight degree at the left apex, which at the present time is the seat of more activity than that on the right side.

Percussion.—Percussion confirmed the finding on palpation. Left.—*Anteriorly.*—There was slight impairment of the percussion note to the second rib. *Posteriorly.*—Slight impairment to the upper third of the scapula. Right.—*Anteriorly.*—Moderate dullness to the fourth rib. *Posteriorly.*—Moderate dullness to the lower third of the scapula, with tympany near the apex, confirming the suggestion of cavity noted on palpation; and, slight impairment from the lower third of the scapula to the base.

The position of the heart was normal and confirmed the findings on palpation.

Auscultation.—LEFT.—*Anteriorly.*—A decidedly roughened inspiration with slight harshness and a few fine and medium râles on coughing to the third rib. *Posteriorly.*—Decidedly roughened inspiration with slight harshness and a few fine and medium râles on coughing above the spine of the scapula posteriorly, and decidedly prolonged expiration due to emphysema, to the base. RIGHT.—*Anteriorly.*—Rough harsh inspiration with harsh prolonged expiration and numerous medium râles to the third rib. *Posteriorly.*—Rough harsh inspiration with harsh prolonged blowing expiration, whispering voice and many medium râles above the spine of the scapula, and the same respiratory sounds and râles without the blowing to the lower third of the scapula. Breath sounds were weak over the base.

Tuberculin Reaction.—The von Pirquet test was positive, reaching its maximum within twenty-four hours, the reaction to full strength Koch's Old Tuberculin, being 3/4 c.c. in diameter.

Laboratory Findings.—

Sputum:	Date Nov. 19, 1917 5 c.c. mucopurulent 2 bacilli to the field
Urine:	Through an error, only a specimen instead of full 24 hour quantity of urine was taken, but this showed no sugar, no albumin, no diazo, indican normal, specific gravity 1034.
Blood:	Hemoglobin 90% Leucocytes 8,650

Diagnosis.—The patient was suffering from a chronic fibro-ulcerative tuberculosis. There was cavity formation at the right apex posteriorly and many small areas of caseation in the right upper lobe and a portion of the lower; disseminated tuberculosis throughout the rest of the right lung and a new infection with the beginning of necrosis in the left lung; a moderate degree of collateral inflammation; and pleural adhesion at right base. The condition of the lungs is shown in Fig. 148, page 565.

Prognosis.—The chance in this case for an arrestment was quite good in spite of the cavity in the upper portion of the right lung. This prognosis was favored by the fact that the patient had developed considerable immunity owing, first, to the fact that she had had the disease in active form for quite a long time; and, second, because it had for the most part taken a slow course showing a low degree of toxemia.

Analysis of the Case.—This case presents many interesting conditions and forces upon us again the importance of tuberculosis of the pleura being diagnosed as tuberculosis and taken seriously. This patient had definite tuberculosis, at the time of her first attack of pleurisy, when twenty years of age; again five years and two years prior to the time she consulted me. Pleurisy is one of the symptoms which is caused by the tuberculous process *per se* (Vol. I, page 391), and consequently demands that a diagnosis be made. It is not necessary to wait until gross symptoms are found in the lung. Pleurisy usually means subpleural tuberculosis—an involvement of the tissues and lymph spaces immediately below the pleura. This is just as much tuberculosis as though it was in another situation where râles would be produced. This patient also had a decline in health, five years prior to the time when the diagnosis was made and had repeated declines following that, accompanied by loss in weight, and cough so severe that vomiting ensued.

Unfortunately, this patient was one who did not expectorate. At the time of my first examination I asked the question. "How much do you expectorate?" She replied: "None," and that she had never expectorated; yet I found evidence of cavity in the lung. During the examination she coughed but failed to expectorate. I said to her: "You raised then." She said: "No, I did not;" but I found that the sputum had raised to the throat and that she had swallowed it. She then told me that she had been doing this for a long time unconsciously. With some difficulty I taught her to expectorate the sputum and found that she was raising about 15 c.c. of mucopurulent sputum per day. In another patient under my care some years ago, we found bacilli in the stool although he denied expectoration. Later he found that he was swallowing the sputum, the same as this patient.

During the five years prior to her consulting me she had been examined repeatedly, and consultants had been called in to allay the husband's fears; and all had told her the same thing, that there was nothing the matter with her lungs. This opinion was given, when clinical history alone, without regard to the examination of the chest, should have settled the matter definitely in favor of a probable diagnosis. Even in the spring of 1914, when she lost weight, became exceedingly thin, experienced a marked decline in general strength and coughed so hard that she vomited almost daily, a diagnosis was not made. On the contrary, the patient was reassured and told that there was nothing the matter.

One of the reasons why a diagnosis was not made, although repeated examinations of the chest were made, was probably owing to the fact that this disease took upon itself a form of widespread fibrous tuberculosis and revealed few signs on auscultation. We not uncommonly find such a condition present; and the diagnosis must be made largely on clinical history unless the chest be examined by a specialist.

Another feature of interest in the case was that she never appeared to have much fever, although her temperature had not been taken with any regularity.

Upon her entrance to the institution, after making my diagnosis, I found it exceedingly difficult to persuade the patient that the condition was serious. She rather looked upon the matter as a joke. She had been assured by so many physicians that there was nothing the matter that it was impossible to get her to fully realize her condition until such time as we had gained her confidence.

The condition at this time showed a slowly progressive tuberculosis of the fibro-ulcerative type in which the fibrosis predominated. Both lungs were involved, but the right one far more seriously than the left. The temperature was not much above normal, ranging during the first two or three weeks in the neighborhood of 99°. The temperature and pulse curves are shown in Fig. 149, page 564.

Course of Disease During Treatment.—The patient was put to bed and kept quiet during the first month. The second day after her admission to the institution she had a slight trace of color. It will be noticed by the temperature chart that beginning about the same time the pulse began to increase in rapidity. On the fifth day the temperature began to rise, increasing each day until at the end of a week it reached a maximum of between 100° and 101°. This was accompanied by increased cough. The cause of this rise in temperature and increased cough was the softening and expulsion of a small tuberculous mass. It will be noticed that immediately following this the temperature and pulse both settled down to a regularity that was not noticed previously and that both became gradually lower until, by the end of the first month, the temperature was normal and the pulse 80.

Another interesting thing is shown by the temperature chart during the first month. It will be noticed that immediately following menstruation, which occurred on the 11th of December, there was a drop in the temperature. The temperature assumed a lower plane than previous to the menstrual time. This low level was continued until the 23rd of December, which was about the middle of the month, and then it will be noticed that it assumed another higher plane, which continued until after the menstruation again. While this is not shown definitely in this chart as it is in many others, yet it is quite marked. This premenstrual rise is probably due to the stimulation of the sympathetic nervous system by ovarian secretion as discussed in Vol. I, page 195.

It will be noticed that on the 28th of December the patient had pleurisy. There was a greater irregularity of the temperature curve following this for a short period. The pulse also became somewhat higher, reaching a maximum of about ten beats higher than before this attack.

About the first of the year the patient was allowed to sit up, and become more active. This accounts for the continuation of the rapid pulse which began with the pleural inflammation.

It will be seen that this patient was put on tuberculin and given doses at first rather frequently, the intervals gradually increasing as the doses increased in size. At no time was there a reaction or anything that could be interpreted as such, although at the end of the first month the dose was 100,000 times greater than the dose which was first administered. It will further be noticed that, instead of increasing by five or ten times the previous dose, after the end of the first month I increased the doses only by half the previous dose. My reason for this was that these doses were sufficiently large to produce focal stimulation and I only wanted to maintain a slight focal reaction on account of the amount of activity in the lung. Had this case been wholly of the fibrous type, or, had it been an early case, then I would have continued increasing the doses ten-fold each time.

The beginning of the administration of tuberculin in this case would have been unfortunate in the hands of one with little experience in the use of tuberculin; for, when the temperature began to rise, as it did following the second dose, administered on the 22nd of November, the probabilities are that he would have thought that this rise was due to reaction. He most likely would have thought that the dose was too large, and he probably would have made the mistake of waiting for a week or ten days before administering his next dose.

That this rise in temperature was not due to the tuberculin, I know, because the dose is not sufficiently large to produce a focal reaction. I have never seen a focal reaction follow these small doses. My second reason for knowing that it was not due to the tuberculin is because it was followed by increased expectoration and all the symptoms which go with the breaking down and expulsion of a tuberculous necrotic mass.

These conditions occur more or less commonly in advanced tuberculosis whether tuberculin is employed or not; and unless the physician bears this in mind, he will continually misinterpret them and consider them as due to the tuberculin. On the other hand, such rises in temperature might be due to it; but, if the dose is suited to the pathological conditions within, there is very little danger.

The man who administers tuberculin must know the condition of the patient's chest. The pathology within the lung must be considered just as carefully as the temperature chart or any other visible guide.

If the third dose which was given had been given on the 24th of November instead of on the 26th, the rise in temperature noted might have been erroneously interpreted as being due to a tuberculin reaction. The same thing could be said at other times. Had a dose been given on the 23rd of December, how easy would it have been to have said that it was due to the tuberculin, the same on the 30th of December and on the 2nd of January.

These last three rises of temperature were due to different things, the first to slight stomach disturbance, the second and third to worry on the part of the patient.

To administer tuberculin intelligently, each of these rises must be considered not only in connection with the disease but in connection with what the patient does and all the little complications that arise. Such things as worry, excitement, overeating, exercise, and stomach disturbances are all accountable for slight elevations in temperature, which, while usually temporary, may be more or less prolonged.

It will be noticed that after the slight rise in temperature which occurred during the early part of April, there was no further rise except those due to the premenstrual disturbance, until the end of treatment.

The last dose of bovine tuberculin was given this patient on the 23rd of March. This was a fairly large dose, and owing to the amount of involvement in the lung we felt that it was better not to produce any marked focal stimulation; so, on the 4th of April we began to use the human preparation. The method of administering this remedy was practically the same as it was at the beginning of the treatment. This being a different preparation, we started in in the same manner and increased gradually, as long as the patient was under treatment. At no time was there any difficulty experienced in the administration of tuberculin. The slight rise in temperature noticed on the 7th day of June, on the day on which 4t. (.004). T. B. V. was given, might be taken by some to be due to the dose, but this rise has a different explanation. In the first place, it will be seen that it was immediately prior to menstruation, so we have this factor to deal with. Another note that was made at the time was that this patient, on this day, stayed in the sun for quite a while and found that the temperature rose immediately following it; consequently, these other factors must be considered, and are probably the real cause of the rise. This is made all the more probable if one will observe the action of the temperature during the period. Prior to the menstrual period which appeared on the first day of April it is not so noticeable. It was quite noticeable, however, in that which appeared the 5th day of March, and a slight change is also observed in that of the 5th of February.

These premenstrual rises of temperature vary greatly. Sometimes they are very marked and sometimes barely noticeable. The duration of the rise is also variable. In some cases, it will run two weeks to a day; in others, it will last only two or three days. It is very important to understand this premenstrual temperature, if one is to have an intelligent idea of what is producing temperature elevations in tuberculous women.

This patient represents an average type of those who are suffering from a moderately active advanced tuberculosis. It will be noticed that the temperature and pulse curve became steady as time went on; so that, after the fourth month, there was little variation noticed. At this time, the active inflammation in the lung had come to a standstill, and the patient, thereafter, showed no symptoms of toxemia.

The gain in weight shown by this patient was very gratifying. On entering the institution her weight was 120 pounds. At the end of the third month it was 130; at the end of the fourth month it was 136, and on leaving it was 137½. This gain in weight did not come by forced feeding. It came naturally. As soon as the patient was put under proper treatment, which consisted of rest, open air, hopeful and healthful surroundings, and tuberculin, the appetite at once improved of its own accord. This was followed by a gradual increase in weight. Had this patient been stuffed, she could have put on weight much faster; but gain in weight, as I have frequently emphasized in these pages, does not mean cure; in fact, it does not, necessarily, mean improvement. To be sure, the ability to put on weight is of value; yet if weight is stored up by overeating, it is of no value to the patient, and proves nothing as to what the future outcome is to be. A gain in weight is not always prognostically good. A gain of weight, under the eating of normal amounts of food, however, does offer good reason for encouragement.

Laboratory Examination at Termination of Treatment.—

Sputum:	Date	June 10, 1915
	Quantity (3 days)	3 c.c.
	Sediment	1
	Bacilli per field	1 —

Urine:	Date	June 8, 1915
	Quantity (24 hrs.)	1100
	Specific gravity	1026
	Albumin	negative
	Sugar	negative
	Diazo	negative
	Indican	slightly increased
Blood:	Date	June 8, 1915
	Hb.	85
	White cells	12,850

After History.—The after history of this case teaches a very important lesson. This patient left the sanatorium with one c.c. of sputum per day, which did not average one bacillus to the field. She was in normal weight and practically free from clinical symptoms; yet she was not well. As I have emphasized throughout these pages, no patient gets well of advanced tuberculosis in a few months' time. I urged this patient to continue treatment. I had a feeling of certainty that if she would continue her treatment for four or five months more, she would attain a permanent arrestment; but, other factors entered and she disregarded my advice and left the institution, with the promise to return after three or four months to resume treatment; or sooner, if symptoms should manifest themselves.

Not long after leaving the institution she was taken with a severe cold, a bronchitis. This was followed by an exacerbation of symptoms, and there must have been,—although I do not know the definite history,—a rapid spreading of the infection, for the process went on steadily and the patient died nine months after leaving the sanatorium.

The death of a patient like this should not count against the treatment of tuberculosis. This patient had made good progress in the way of overcoming her disease, in the seven months that she was under treatment. The difficulty here was that there was an attempt on her part to do eighteen months' work in seven months' time. The start that this patient had, if continued, would have led to the regaining of health almost without question.

Those who are interested in seeing the treatment of tuberculosis placed on a safe and sane basis, cannot emphasize too strongly the importance of treating patients until the best result possible is obtained. There is a tendency to try to shorten the period of treatment, to take the disappearance of clinical symptoms, particularly those of toxic origin, as meaning a cure of the disease. Such an attitude is fatal to the cause of tuberculosis therapy. Physicians must learn, and they must impress upon their patients, the fact that the clinical relief from symptoms, and pathological healing of tuberculosis are two entirely different propositions.

Of the three groups of symptoms in tuberculosis,—those due to toxemia, those of reflex origin, and those due to the disease itself, the toxic group is the one which usually disappears first. The toxic group is only present during the periods of acute inflammation, with the multiplication of bacilli and necrosis. Tuberculosis, however, is a chronic inflammatory disease. The danger to the patient's life cannot be measured by the degree of toxemia present, because a severe toxemia may pass away and the patient be free from all symptoms produced by it, and the patient may still have a very serious pathological process to deal with. Fortunately, from the standpoint of understanding the disease, those symptoms due to reflex action do not pass away so readily,—cough, hoarseness, reflex stomach disturbance, may remain for prolonged periods. So do those symptoms belonging to the group caused by the tuberculous process itself. There is no time when active tuberculosis is present that there cannot be a tuberculous pleurisy, although attacks of acute pleurisy become less as healing proceeds. The last tubercle in the lung might be in a blood vessel, and, rupturing, might produce a hemorrhage; or, when the disease is arrested, small blood vessels in a cavity might be injured and produce a slight leakage of blood; consequently, hemorrhage might occur as one of the very last symptoms before healing takes place. The occurrence of these symptoms after the patient has been under treatment for a long time is very discouraging to the patient, and usually calls forth some such expression as: "I do not see how I can be getting well if I can have a hemorrhage." This symptom may be the last to disappear, and must be taken at its true worth, as indicating that the pathological process changes much more slowly than the clinical symptoms.

Tuberculous sputum is also very slow to disappear. Very often when a cavity is formed a small amount of sputum will

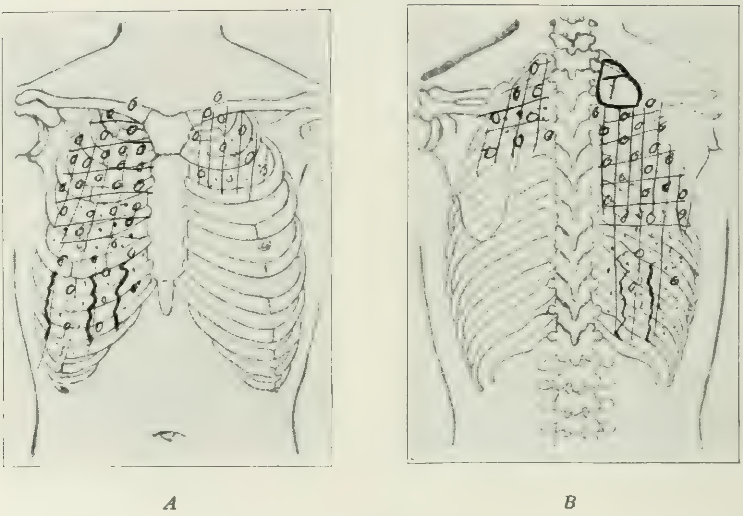
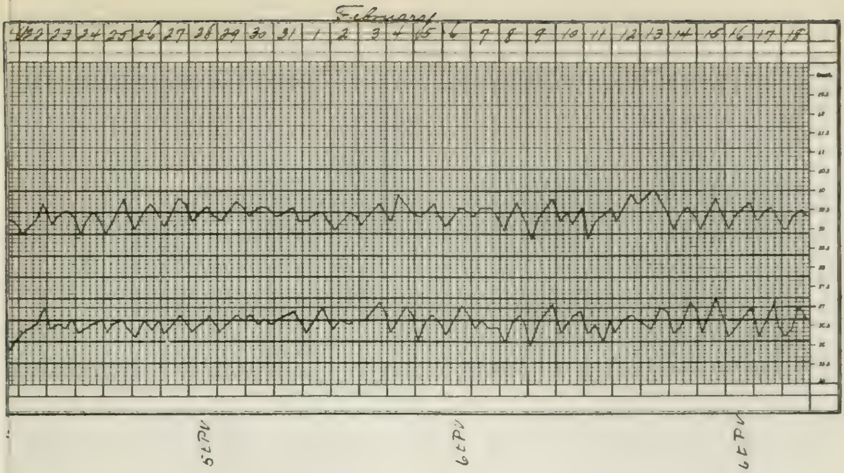
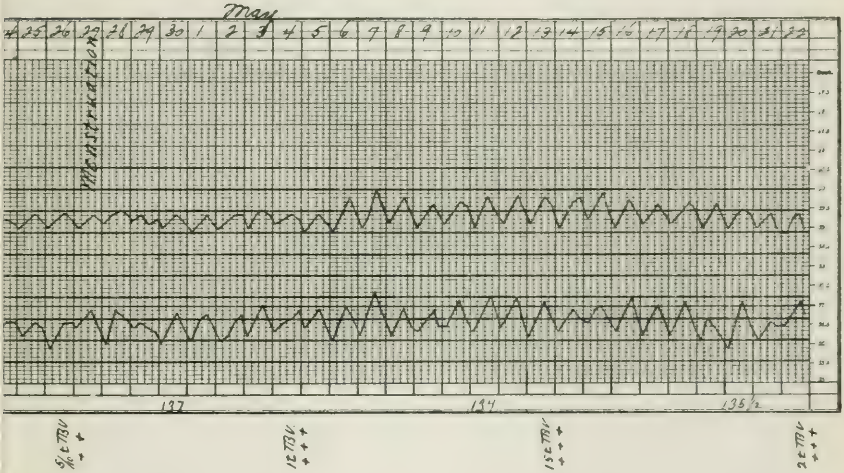


Fig. 148.—Charts of chest, Case 2542.





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ower curve, temperature.

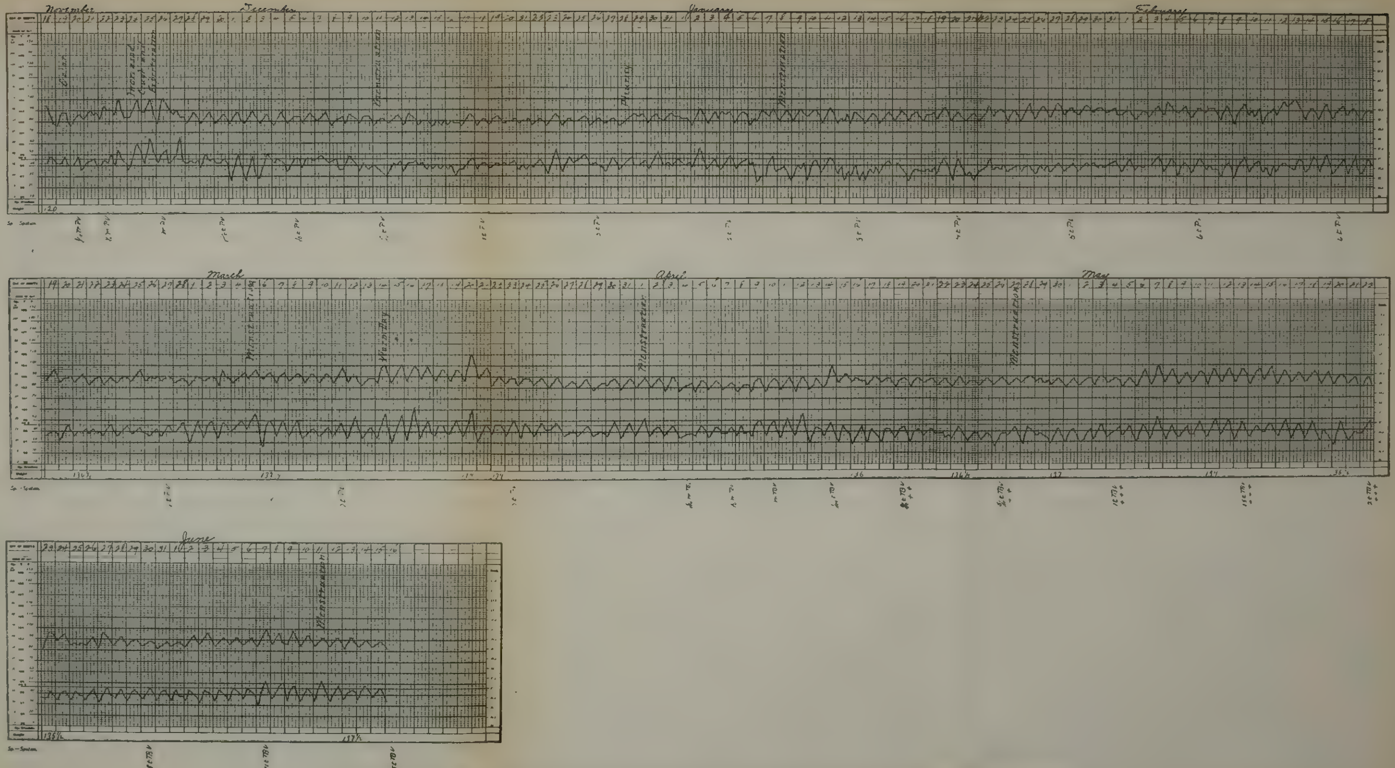


Fig 149.—Charts showing temperature and pulse curves, with clinical notes and doses of tuberculin, Case 2542. Upper curve, pulse; lower curve, temperature.

remain, even after every other sign of healing has taken place. That symptom of tuberculosis, which I have described as tuberculous bronchitis,—the so-called "colds" from which these patients continually suffer, is a symptom which usually disappears early in the process of healing, although it may recur at any time until activity is over. It is a frequent cause of the symptoms of acute toxemia, which occur during the course of tuberculosis, and which pass away after a few days or two or three weeks at most.

CASE 1999.

EXTENSIVE FIBROCASEOUS TUBERCULOSIS OF ENTIRE LEFT AND UPPER RIGHT LUNG; THICKENED PLEURA LEFT BASE; COMPENSATORY EMPHYSEMA ON RIGHT; MEDIASTINUM SHIFTED TO LEFT; MYOCARDITIS; PARTIAL HEART BLOCK; CHRONIC COURSE WITH IMPROVEMENT; COMPLICATED BY HEMORRHAGES; PNEUMOTHORAX AND DILATATION OF THE HEART. DEATH. OBSERVED FROM NOVEMBER 1, 1912, TO OCTOBER 4, 1913.

A Discussion of: The Relationship of Association with Tuberculosis and Infection; Wrong Advice Until Disease Becomes Active; Course of Moderately Active Advanced Tuberculosis with Periodical Cavity Formation; Pneumothorax; Tuberculin Therapy; and Myocarditis.

Case 1999.—Male. Age 42 years. Entered the sanatorium November 1, 1912.

Family History.—Father living and well. Mother died at the age of thirty. The patient did not know the cause of her death, but knew that her illness started with a cold. One paternal uncle died of a pneumonia, the nature of which is questionable. One maternal aunt died of hemorrhage of the lung. Patient associated with this aunt during her illness.

Personal History.—Patient had diphtheria, scarlet fever, and measles as child. He used alcohol moderately, no tobacco. Has been confined to indoor work, working very hard for eight years.

Tuberculous History.—Patient caught a severe cold in November, 1911, which did not disappear. A physician was called in December. He had another cold in January, at which time the sputum was examined and bacilli found.

The early symptoms which would ordinarily point to tuberculosis, such as malaise, loss of appetite and nervous instability were, in his case, wrongly attributed to business worries. He had some hoarseness, tickling in larynx, and cough.

The symptoms in this case could be tabulated, according to their etiology, as follows:

SYMPTOMS DUE TO

Toxemia	Reflex Stimulation	Tuberculous Process *per se*
Malaise	Hoarseness	Tuberculous bronchitis
Lack of endurance		
Nervous instability	Cough	Sputum, bacillus-bearing
Loss of appetite		
Loss of weight		
Rapidity of pulse		
Fever		

Examination.—The patient came for examination on the 1st day of November, 1912, at which time he weighed 165¾ pounds, being 19¼ pounds below his normal weight. This loss had taken place since July, 1912. At the time he consulted me he suffered from dyspnea, was markedly cyanotic, had poor appetite, and showed great mental depression and anxiety.

Condition of the Muscles and Subcutaneous Tissue.—The condition of the muscles and subcutaneous tissue is shown in the following table in which the — sign is used to indicate degeneration, and the + to indicate spasm. The degree of spasm and degeneration is indicated by the number of signs; one meaning slight; two marked, and three very marked.

	RIGHT		LEFT	
	Degeneration	Spasm	Degeneration	Spasm
Sternocleidomastoideus	—	+	— —	+
Pectoralis	— (upper fibers)	+	— —	+
Trapezius			— —	+
Levator anguli scapulæ			— —	+
Rhomboidei			— —	+
Degenerated subcutaneous tissue	Slight to third rib and to upper third of scapula posteriorly		Marked over entire left anteriorly and posteriorly	
Lessened motion.	Slight		Very marked	

Palpation of Total Resistance.—Left.—*Anteriorly.*—Palpation of total resistance on the left, anteriorly, showed marked increase in resistance from the second to the fourth rib, with an area of decreased resistance to the palpating finger indicative of cavity above the second rib. Moderately increased resistance from the fourth rib to the base. *Posteriorly*—Marked resistance above the lower third of the scapula, except from the apex to the upper third of the interscapular space, where there was a marked decrease in the resistance suggestive of cavity. The increased resistance from the lower third of the scapula to the base was indicative of thickened pleura and scattered infection. RIGHT.—*Anteriorly.*—Moderately increased resistance from the apex to the third rib. Increased tension, with decreased total resistance from that level to the base, indicative of emphysema. *Posteriorly.*—Moderate resistance to the palpating finger to the lower third of the scapula. Increased tension, but decreased resistance from the lower third of the scapula to the base, indicative of emphysema.

The left border of the heart on palpation was one inch to the left of its normal position, the right border being practically normal, showing that the heart, as a whole, was enlarged.

Suggested Diagnosis from Inspection and Palpation.—From the marked degeneration of the subcutaneous tissues and muscles over the left side we infer that there is a wide spread chronic lesion throughout that lung. The increased total resistance, together with the doughy inelastic feel of the soft tissues over the left base, indicate the presence of thickened pleura. The fact that aside from degeneration the apical muscles also show slightly increased tone would indicate that this is an old lesion on this side, and the seat of activity at the present time. The lack of resistance on deep palpation near the apex, both anteriorly and posteriorly, suggests loss of tissue with cavity formation. Slight degeneration of the apical muscles and subcutaneous tissue on the right indicates that the lesion in this lung is also of long standing. The fact that these muscles show increased tone at the present time indicates that the process is active. The feeling of tension with decreased total resistance over the right lung from the third rib and the middle of the scapula to the base, indicates that this portion of the pulmonary tissue has taken upon itself compensatory emphysema.

Percussion.—LEFT.—*Anteriorly.*—Marked dullness to the fourth rib, with dull tympany above the second rib. Impaired resonance from the fourth rib to the base. *Posteriorly.*—There was marked dullness to the lower third of the scapula, except from the apex to the upper third of the interscapular space, where there was dull tympany indicative of cavity. The note was impaired from the lower third of the scapula to the base. RIGHT.—*Anteriorly.*—Moderate dullness to the third rib. Hyperresonance from the third rib to the base. *Posteriorly.*—Slight dullness to the lower third of the scapula and hyperresonance from the lower third to the base.

Percussion confirmed the outline of the heart as noted on palpation.

Auscultation.—LEFT.—*Anteriorly.*—Revealed rough harsh inspiration with prolonged expiration, blowing in character near the apex, with numerous medium râles from the apex to the 4th rib and the same character of breathing, though of less intensity and with few râles to the base. *Posteriorly.*—Breathing showed blowing character near the apex and rough harsh inspiration with harsh prolonged expiration with many medium râles to the lower angle of the scapula. The same character of breathing, though less marked, to the base. The respiratory note was decidedly weak over the posterior portion of the left lung. RIGHT.—*Anteriorly.*—Slightly rough harsh inspiration with slightly harsh prolonged expiration with few medium râles to the third rib anteriorly and the middle of the scapula posteriorly. Marked prolonged expiration indicative of emphysema to the base.

All heart sounds were weak. There was a marked irregularity; and, at times, the patient showed two contractions of the auricle to one of the ventricle.

Laboratory Report.—

Sputum:	Date	Nov. 15, 1912.
	Quantity (24 hrs.)	15 c.c.
	Moderate numbers of	bacilli to the field
	Sediment vol.	5 c.c.
Urine:	Quantity (24 hrs.)	750 c.c.
	S. G.	1028
	Sugar	negative
	Albumin	negative
	Indican	normal
Blood:	Hemoglobin	90
	White cells	11,050

Diagnosis.—Chronic widespread fibrocaseous tuberculosis involving the entire left lung and upper half of the right, with extensive excavation at the left apex; pleural thickening at the left base; and emphysema at the right base; myocarditis. The condition of the lungs is shown in Fig. 150, page 578.

Prognosis.—The prognosis in this case is bad. The widespread disease with the low degree of temperature and general condition of the patient indicates that the infection was not one of great virulence. This favorable fact was overbalanced, however, by the fact that the disease had begun to show widespread necrosis and by the fact that the heart muscle was the seat of marked myocardial change.

Analysis of the Case.—Analysis of this case shows a history in which repeated colds seem to be the most important factor indicative of activity during the early period. Other symptoms which were present were entirely overshadowed by the physical and mental condition of the patient, he being considerably rundown by hard work and business worry. The result of business worries often simulates the early symptoms of tuberculosis.

The fact that this patient associated with his aunt who had tuberculosis must not be taken as meaning that this was the probable source of infection. We now believe that most adult cases of tuberculosis are metastases from early infections in childhood, and that a casual association in adult life is of little danger; in fact, the evidence is strong that adults who have been protected by immunity resulting from infection are only endangered at a later period by intimate and prolonged contact with open tuberculosis.

As far as he knew, he was perfectly well in November, 1911, when a sudden cold appeared, followed by another one in December, with the finding of bacilli one month later.

It is evident from our modern studies of tuberculosis that the focus which became active at the time of these colds was in the lung before this time. Just when the metastatic focus had formed we have no way of knowing; but this case, like many others, shows that the earliest signs which manifest themselves when infection extends to the lung are usually overlooked, probably because of the apparent lack of importance. This patient, however, probably did show symptoms prior to his breakdown, which he has now forgotten and which were not seriously considered at the time.

A diagnosis of tuberculosis was made in January, 1912. The patient came to California and decided to enter the sanatorium but was persuaded by friends that it was unnecessary, and that rest was all that was needed. He improved, and in July attained a weight of 185 pounds, the highest he had ever reached. He spent his time enjoying himself, taking the gain in weight which resulted from the change of climate, and rest from work as indicating that he was getting well.

In September, 1912, however, as a result of overexertion, with too little rest, the patient began to show signs of renewed activity and friends advised him that another change was necessary. Thinking that he might do better he went to a neighboring town; but, as he continued to lose, he decided to enter the sanatorium.

On entering the institution the patient was suffering from a very widespread lesion. The left lung was infiltrated from the apex to the base. Throughout the entire lung there were scattered areas of softening. Near the apex, both anteriorly and posteriorly, cavities had formed.

The upper half of the right lung was infiltrated and also showed some evidence of softening. The lower portion was markedly emphysematous.

The heart was large and showed clinical symptoms of myocarditis.

Course of the Disease.—The temperature and pulse curves are shown in Fig. 46. The general appearance of this patient and the widespread lesion in the lung were in no wise in keeping with his temperature curve. One would consider in looking at his temperature curve that he was suffering from little activity, but the patient was in an extremely precarious condition. This was not wholly due to the lung. The heart was a big factor and it is probable that if he had had a good heart, he would have had fairly good chances of an arrestment. That the infection was not markedly virulent we infer from the fact that the disease was widespread and active without marked symptoms of toxemia.

His first month's chart is extremely interesting. It will be noticed that on the second day after entering the sanatorium his pulse dropped from above 80 to below 60; and, that, on the fifth day following, it increased to 80, and, a few days later, to 90. It continued on this high plane for nine days and then dropped again to 50 beats, which continued for five days. A point of interest in this pulse was that during the low count, practically every other beat was dropped. I examined him during this time repeatedly and found that only every other auricular contraction was going through, the patient suffering from a partial heart block. The count as given by the patient, was not absolutely accurate; for my assistants, as well as myself, listened to the heart on various occasions and found two auricular contractions for every beat of the ventricles. Another thing of interest is that this failure of the auricular contraction to be conducted to the ventricle, came on with a rise in the temperature curve, which was well marked during the first period, and only slightly marked during the second period; but sufficient to suggest that there might be a causative relationship between the increased activity and toxic absorption from the lung, and the heart disturbance.

It will be noticed that the patient's temperature began to improve and was practically normal except for occasional rises lasting over a period of a few days, until the fifth month, although careful observation will show that the temperature, while not showing a wide daily variation, does show slight waves at intervals of about two weeks during the earlier period. One of these intervals during the latter part of March was followed by quite an increase of expectoration, which shows that the cause of the increased fever was associated with pulmonary inflammation and expulsion of a caseous focus.

The patient's weight had increased to 180 pounds by the end of the third month; but, by the end of the fifth month, it had dropped back to 176½ pounds.

Each of these upward waves in the temperature curve was unquestionably due to activity in some focus in the lung. They were each accompanied by other symptoms of toxemia, and several of them were accompanied by the expulsion of a necrotic mass, as evidenced by the character of the sputum, as well as the increase in its amount.

About the middle of April there was a very sharp rise in temperature which lasted for three days. This was accompanied by bloody expectoration. Immediately following, the temperature became more regular than it had been previously; and, for a month, it was extremely regular. The explanation is that during this rise of temperature which was followed by the spitting of blood, there was a rupture of a focus which had probably been intermittently active for some time and which had been keeping up these waves; consequently, the patient was given relief.

Following this, for the next month, the system was able to care for all the toxins absorbed, without the production of a rise of temperature.

On the 22nd of May there was another slight rise of temperature which was also accompanied by irregularity of the heart. This was followed by a period of more regular temperature and later by a drop in the pulse of some twenty beats.

About the middle of June both pulse and temperature curves began to go a little higher, the inflammation in the lung increased somewhat, and, on the 23rd of June, the temperature went to 100°. This was accompanied by a marked increase of cough and expectoration, followed by a decline in both temperature and pulse, showing that there had been definite relief from the inflammation within the lung and that the system was rid of the focus which had been discharging toxins into the circulation.

This was followed by another slightly high curve in both pulse and temperature between the 4th and 11th of July, and again from the 27th of July to the 5th of August.

Things then went along very well; the patient's general condition improved. He had previously lost some weight but during July and the early part of August he regained it.

On the 17th of August the pulse and temperature both began to rise and on the 22nd the temperature reached 103.4°. This was a sharp rise, being nearly four degrees higher than the maximum of the previous day. One reason why this was so high was probably because of the greatly increased amount of coughing. The cough and expectoration were both very markedly increased, indicative of the expulsion of quite a large amount of caseous material. Again the pulse and temperature declined and the patient improved.

Another increase in temperature and pulse rate occurred, which was accompanied by a very marked rise on the 15th, the temperature reaching 101.5°. The reason that the temperature on this date was so much higher than the days preceding or following was due to the extra amount of cough the same as pointed out above. On this day the patient coughed quite heavily and expectorated freely. The temperature, however, did not decline to normal; and, on the 24th of August, the patient had a hemorrhage of about three ounces.

On the 26th of September it will be noted that there was a decided rise in both pulse and temperature. At this time the patient developed a left-sided pneumothorax. The symptoms at this time were: some pain, great anxiety, much shock, and marked dyspnea.

Physical examination showed the heart pushed considerably to the right and diminished breath sounds and more or less tympany over the lower portion of the left lung. The shock and anxiety, together with the dyspnea which the patient showed, were partly due to the extra strain thrown upon the weak heart.

It will be noticed that the temperature began to drop on the 1st of October and the pulse began to show a slight rise at this time, but a more steady rise began on the 7th of October. This was marked by an increased area of heart dullness, due to dilatation of the right ventricle.

The patient died with a pulse rate above 140 and a temperature below normal on the 14th day of October, 1913.

Laboratory Examination at Termination of Treatment.—

Sputum:	Date	Sept. 8, 1913.
	Quantity (24 hrs.)	20 c.c.
	Sediment vol.	5 c.c.
	Bacilli per field	1
Urine:	Date	Sept. 8, 1913
	Quantity (24 hrs.)	900
	Specific gravity	1025
	Albumin	negative
	Sugar	negative
	Diazo	negative
	Indican	normal
Blood:	Date	Aug. 8, 1913
	H.b.	90
	White cells	11,150

Comment.—There were several interesting things in this case. First, the myocarditis was a serious complication from the very beginning. Yet, in spite of this, and in spite of the extensive disease in the lung, the patient made splendid improvement, although the disease never became wholly quiescent. The curves which marked the rise in temperature are characteristic of tuberculosis and came with considerable regularity every two or three weeks; but were insignificant during the first four or five months of the patient's treatment. At the end of this time they became more marked and this increase kept on until the patient's death.

During the last four or five months of life, however, the patient was not in a serious condition. During most of this time he was feeling fairly well and there was every reason to feel encouraged about him, in spite of the fact that the temperature curve was a little higher than it had been in the earlier part of the treatment.

During this period there was no particular cause for alarm because the patient's clinical course was in keeping with the pathological changes that were going on in the lung. It is necessary to bear in mind that all patients who have advanced tuberculosis, with necrotic areas must, now and then, have some inflammatory condition about these areas, which are associated with increased activity in the focus and are quite often followed by an expulsion of cheesy contents. The patient must not be expected to escape these, for they are a necessary method of ridding the body of the contents of a tuberculous abscess; neither must he expect to feel well during the period when the temperature is high, for other symptoms of toxemia are also present. Fortunately, however, the toxemia is only temporary, lasting four or five days, after which it improves, the symptoms decrease, and the patient has an opportunity to pick up before the next rise appears. So, if the patient holds his own in a general way during the period when this is occurring, the outlook is good; and, providing that it does not keep up too long and destroy too much tissue such changes are not inconsistent with an arrestment of the disease. Too often the physician who is treating the case, as well as the patient, becomes anxious and thinks the treatment instituted is not doing the patient good or that it is doing him harm. The only way to avoid such erroneous ideas is to keep constantly in mind the pathological changes which the patient is undergoing.

When this patient first entered the sanatorium he was put under general hygienic treatment, with the addition of a preparation of bovine tuberculin. There was a very marked improvement in his condition. This improvement continued without abatement. On the 22nd of January quite a large dose of tuberculin was given. This was well borne, but it seemed best, under the circumstances, not to go higher with the dosage, not because of intolerance or because of reactions, but it seemed best not to produce too much focal stimulation because the disease was widespread and somewhat active; so the preparation was changed and human tuberculin given. The patient reacted with local induration on much smaller doses of human tuberculin than he did on bovine, although the preparations are identical in their mode of preparation.

On the 14th of February I again went back to the bovine preparation, which seemed to be tolerated better, although I did not attain as high dosage as I did the first period.

During the latter part of June I again used human tuberculin and the patient showed very marked local induration; so I again stopped short of attaining a high dosage. The patient was then given bovine tuberculin, receiving his last dose on the 7th day of September. It will be interesting to note the method of giving the tuberculin.

At the beginning of each preparation given, the dose was very small, and it was increased rapidly at short intervals; the interval being lengthened as the dose increased in size. It will further be noted that I paid very little attention to the slight rises in temperature which were occurring. This was because I knew they were not due to the tuberculin, but to the natural pathological changes in the tuberculous process in the lung.

On about the 17th or 18th of April, at the time when a dose should have been given, it will be noticed that the patient was having one of his rises in temperature, so I omitted the dose for ten days. This being a little long for the interval for this size dose, I reduced the next dose to one-fifth that of the one previously given. This change was not made because I thought the tuberculin was responsible for the temperature, or because the preceding dose was too large, but simply because the interval was too long.

From that time on we proceeded more slowly in dosage. On the 24th of May a dose was given in spite of the fact that the patient was having one of his high curves. It will be seen that it did not increase the height of the curve. The dose given on the 13th day of June might be considered by some as standing in a causative relation with the rise which followed during the next ten days, but observation shows that this was the time for the rise to occur because these high waves came with considerable regularity. There is a high wave shown at the beginning of the first chart, then slight waves occurring during the course until the end of the fifth month when another high wave appeared. The next came at the beginning of the seventh month; another at the beginning of the eighth month; the next marked rise at the beginning of the tenth month; so, careful observation, together with a study of the pathological changes which were taking place, as shown by the symptomatology, showed that the rises of temperature were due to natural changes in the tuberculous process and not to dosage.

That the rises of temperature during the last two months of the patient's treatment were more marked than others is purely accidental. The one which occurred in the latter part of August was due to the fact that the cheesy focus which broke down and was expelled, was larger and accompanied by more inflammation than the earlier ones. The one which occurred during the middle of September and was followed by hemorrhage and a pneumothorax, does not indicate at all that the patient was not doing well. The death of this patient must be looked upon as being purely accidental. The reason the hemorrhage followed the expulsion of the caseous focus at this time was because the softening came rapidly, before the obliterating endarteritis could close off the small vessels. The reason the patient had a pneumothorax was because the softened area was near the pleura, and, instead of breaking, as it might have done, into neighboring bronchi, it broke into the pleura.

This patient was gaining in weight and feeling very much better during the last two months of life. I have no doubt that could this pneumothorax have been averted this patient would have had excellent chances of going on to an arrestment. The only way to understand a case of this kind is to follow it carefully and compare the clinical course with the pathological changes in the lung.

This sudden rise of temperature and pulse, so well shown in Fig. 151, is one of the most characteristic signs of pneumothorax that we have. In some cases, I have seen none of the usual symptoms, only this sharp rise in temperature and pulse; and ,on physical examination, found a shifting of the heart to the opposite side and a tympanitic area over the part involved. When a patient is under care, with a well kept graphic chart, and we see this sudden rise in temperature and pulse, we should always examine the chest for a pneumothorax. It is not as easily diagnosed where the patient has not been under observation, and such a chart is not kept; but it can, as a rule, be made out, if the case is properly examined and analyzed.

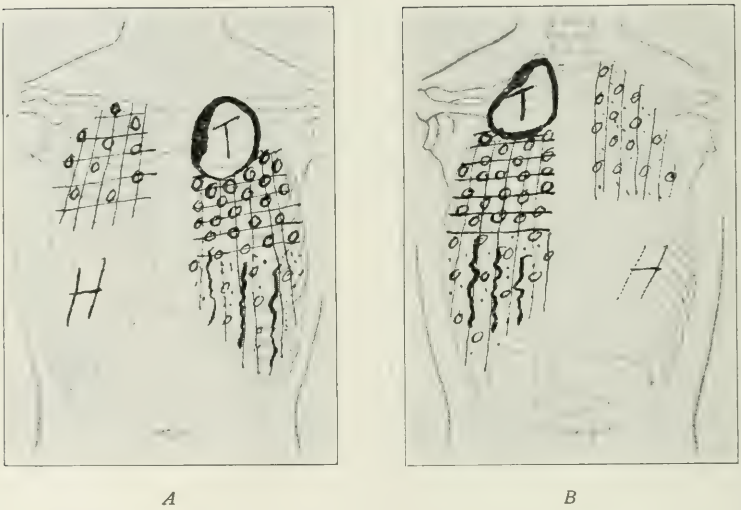
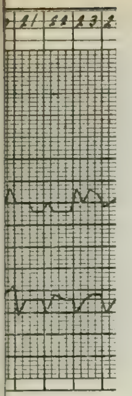
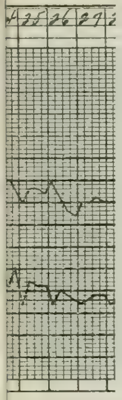
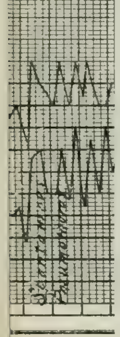


Fig. 150.—Charts of chest, Case 1999.







, Case 1999.

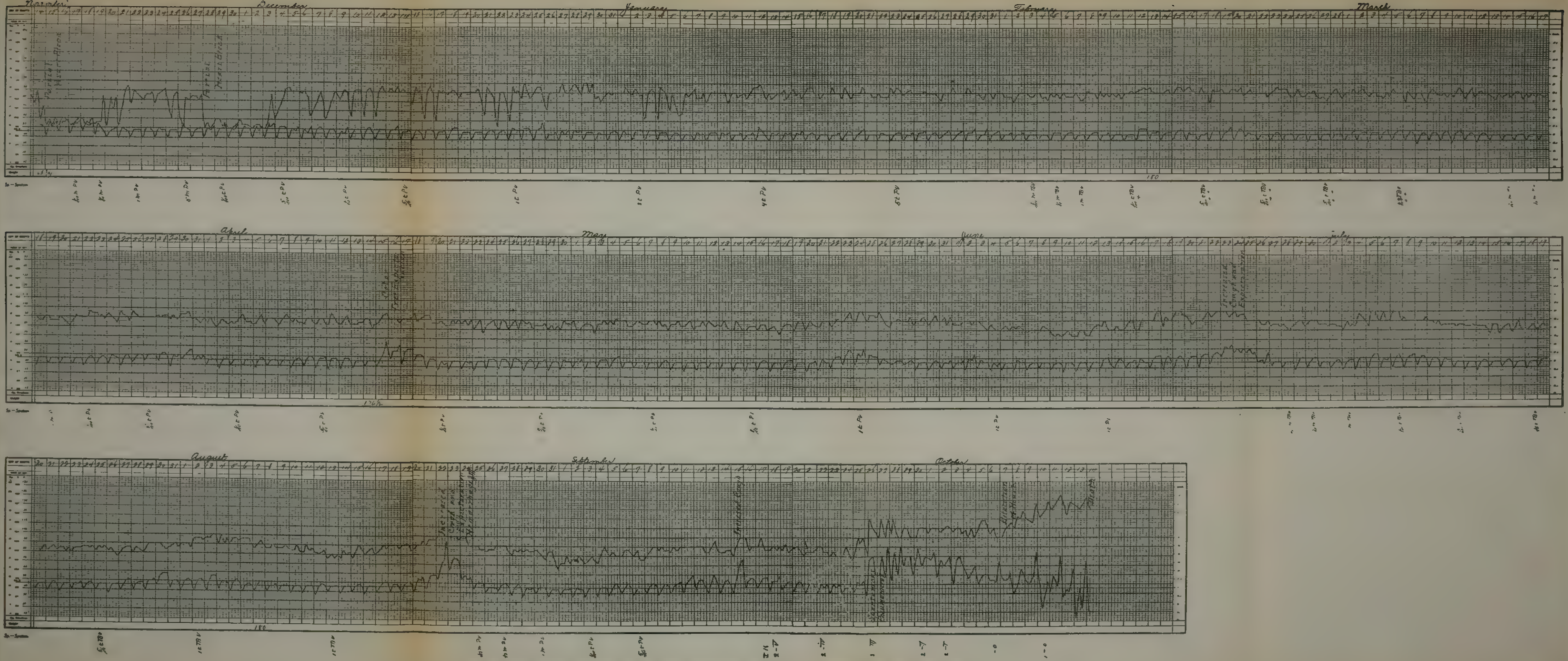


Fig. 151.—Charts showing temperature and pulse curves, with clinical notes and doses of tuberculin, Case 1999. Upper curve, pulse; lower curve, temperature.

CASE 2657.

CHRONIC FIBROSIS, PROBABLY TUBERCULOUS IN NATURE. DELAYED DIAGNOSIS, MARKED ASTHENIA, MARKED NEURASTHENIA, COMPLICATED BY ASTHMA, PULMONARY ABSCESS, GENERAL PTOSIS OF ABDOMINAL VISCERA. IMPROVEMENT. OBSERVED FROM MARCH 1, 1915, TO JANUARY 31, 1916.

A Discussion of: Failure to Diagnose Fibroid Tuberculosis Although Widespread Until Cavity Forms; Difficulty of Diagnosing a New Infiltration Upon an Emphysematous Lung; Causes of Rapid Heart Action; Digestive Disturbances; Pulmonary Abscess; and Treatment of Chronic Fibroid Phthisis Where Bacilli Are Not Found.

Case 2657.—Nurse. Age 53. Entered the sanatorium March 1, 1915.

Family History.—Father died at the age of 84, having an attack of jaundice; diagnosis not made. Mother died at age of 37 of typhoid. Five brothers and three sisters all living and in good health.

Personal History.—Patient had measles, whooping cough, and diphtheria in childhood. Made prompt recoveries. Suffered from multiple arthritis during the past six years. Improved by hot air treatment. Passed through menopause.

Tuberculous History.—At the age of nineteen the patient had a cough continuously from March until July. The patient does not recall other symptoms present at the time. Twenty years ago (at the age of 33) the patient had a pain in left side, which she remembers as giving her considerable concern at the time. Six years ago the patient lost weight quite rapidly. Was run down and had a troublesome squeak in the lung. She consulted a physician who said that there was nothing the matter with her lungs. Three years ago the patient noticed a slight, dry, unsatisfying cough, started by a tickling sensation in the larynx. This was followed a little later by slight expectoration which was blood tinged several times. The patient had considerable pain in the right shoulder which she felt was probably of a rheumatic nature, since she also had pain in other joints. Six weeks ago she had a slight pleurisy on the left side, followed by some night sweats. Beginning about a year and a half ago the patient noticed that her endurance was failing, that she was beginning to lose in strength. During the past six years she has suffered more or less from protracted colds, but repeated examinations by physicians assured her that there was no trouble in the lungs. Tuberculosis was diagnosed three weeks ago by the x-ray. Sputum was not examined because it was thought to be coming from the throat.

Examination.—The patient is poorly nourished. Temperature 98°, pulse 100, blood pressure systolic 125 on the right and 114 on the left. Dyspnea on exertion. Patient sleeps well and bowels are regular.

Condition of the Muscles and Subcutaneous Tissue.—The condition of the muscles and subcutaneous tissue is shown in the following table in which the — sign is used to indicate degeneration, and the + sign to indicate spasm.

	RIGHT		LEFT	
	Degeneration	Spasm	Degeneration	Spasm
Sternocleidomastoideus	— —	+		+ +
Pectoralis				
Trapezius	— —	+		+ +
Levator anguli scapulæ	— —	+		+ +
Rhomboidei	— —			
Degenerated subcutaneous tissue	To fourth rib anteriorly, also to angle of scapula posteriorly.			
Lessened motion	Throughout		At base	

Palpation of Total Resistance.—RIGHT.—*Anteriorly.*—Deep palpation over the entire right lung shows increased resistance which is marked from the apex to the fourth rib. *Posteriorly.*—Marked resistance from the apex to the lower angle of the scapula and slight resistance from there to the base. Very marked dullness over the fourth and fifth vertebræ, and the interscapular space adjacent, indicative of enlarged glands. LEFT.—*Anteriorly.*—Increased resistance from the apex to third rib and an increased tension, but decreased total resistance, indicative of emphysema, from the third rib to the base. *Posteriorly.*—Slight resistance above the spine of the scapula and increased tension, but lessened resistance from there to the base, indicative of emphysema. The entire heart is shifted. Both borders are one inch to the right of its normal position.

Percussion.—RIGHT.—*Anteriorly.*—Marked dullness to the fourth rib, slight impairment of the percussion note from the fourth rib to the base. *Posteriorly.*—Very marked dullness to the lower third of the scapula. Dullness and slight impairment from there to the base, the dullness being more marked over the fourth and fifth vertebræ and the interscapular region adjacent. LEFT.—*Anteriorly.*—Marked hyperresonance throughout, with slightly increased resistance to the finger to the second rib. *Posteriorly.*—Marked hyperresonance throughout with slightly increased resistance to the spine of the scapula.

Auscultation.—RIGHT.—*Anteriorly.*—Rough very harsh inspiration with very harsh prolonged expiration with medium râles above the second rib and fine râles from the second to the fourth rib, which are brought out on coughing. The respiratory note is exaggerated and shows prolonged expiration indicative of emphysema from the fourth rib to the base. *Posteriorly.*—Rough harsh inspiration, with very harsh prolonged expiration from the apex to the lower third of the scapula accompanied by ronchi and medium râles. Harsh inspiration with prolonged expiration, indicative of emphysema from the lower third to the base. LEFT.—*Anteriorly.*—Slightly rough harsh inspiration with prolonged expiration, ronchi, and an occasional râle above the second rib and markedly prolonged expiration from the second rib to the base, indicative of emphysema. *Posteriorly.*—Rough harsh inspiration with prolonged expiration, with medium râles on coughing from the apex to the lower third of the scapula with markedly prolonged expiration to the base, indicative of emphysema.

Examination of the Larynx.—Examination of the larynx shows absence of tuberculous involvement.

Laboratory Examination.—

Sputum:	Date	March 4, 1915
	Quantity (3 days)	30 c.c.
	Sediment vol.	7 c.c.
	Bacilli per field	none

Urine:	Date	March 12, 1915
	Quantity (24 hrs.)	2400
	Specific gravity	1010
	Albumin	negative
	Sugar	negative
	Diazo	negative
	Indican	normal
Blood:	Date	March 2, 1915
	Hb.	90
	White cells	7150
	Arneth index	85
	Lymphocytes	24.8

Diagnosis.—Chronic fibroid tuberculosis affecting the upper lobe, also the upper part of the lower lobe on the right side, with a moderate degree of contraction, and scattered foci throughout the remaining portion of the lung with slight compensatory emphysema. Marked compensatory emphysema of the left lung with slight infiltration in its upper portion. Moderate displacement of the heart to the right. The condition of the lungs is shown in Fig. 152, page 588.

Prognosis.—The opportunity for arrestment in this case is fair.

Analysis of the Case.—This case offers many things of interest. In the first place it shows the great difficulty of a patient suffering from chronic fibroid tuberculosis having a correct diagnosis made. This patient showed very suspicious symptoms when only nineteen years of age, again when thirty-three, and, again, six years ago, when forty-seven. Six years ago when she was running down, losing weight and showing signs of malaise and lack of endurance, she was also suffering from her arthritis, and, consequently, the attention was riveted entirely on the joint condition. She also at this time suffered from squeaks in the lung and consulted a physician on account of it. He considered that it was nothing but asthma and did not make a diagnosis. From that time until this, the patient has suffered more or less constantly with symptoms pointing to the lung. Frequent and protracted colds, more or less constant cough, particularly during the last three years, slight expectoration, gradual loss of weight, running down from 145 to 111 pounds, and sputum slightly blood-tinged, all of which should have made the physician suspicious. During this time she had her lungs examined repeatedly but was always told that there was nothing the matter.

Three weeks prior to consulting me, the diagnosis was made by the x-ray.

It is almost impossible for the patient suffering from fibroid tuberculosis to have the disease recognized during the early stage before ulceration occurs, yet in this case physical examination should have revealed the shrinking of the right lung, and the harsh character of the breathing, also the displacement of the heart, and the compensatory emphysema on the left side, because this had unquestionably been going on for several years.

At the time of entrance this patient was suffering from chronic fibroid tuberculosis involving the entire upper lobe and the upper half of the lower lobe on the right, with enlargement of the bronchial and peribronchial glands, particularly on the right. In the upper portion of this lung, softening was beginning as indicated by the character of the râles. The collateral inflammation had never proved to be very severe, indicating the process to be of comparatively low virulence. The base of the right lung was slightly emphysematous, in order to compensate for the loss of tissue due to the shrinking of the upper portion of the same lung. The entire left lung was considerably enlarged and emphysematous, in order to compensate for the loss of tissue on the right side.

Near the apex there was a new infection implanted upon this emphysematous lung. A secondary infection on an emphysematous lung offers difficulties in diagnosis. If the amount of infiltration is slight it may not be sufficient to overcome the decreased dullness and resistance to the finger on percussion, caused by the emphysema. The ausculatory note is also confusing. Emphysema itself gives a slightly rough character to the respiratory note, also causes a prolonged expiration, much the same as is produced by infiltration, except the expiration is usually soft and of low pitch in emphysema. When râles are present, however, as they are in this case, the diagnosis is not so difficult.

The disease at the present time is not very active although there is the beginning of necrosis above the second rib anteriorly and the spine of the scapula posteriorly.

Course of Disease During Treatment.—The temperature and pulse curves are shown in Fig. 153. This patient was put at rest in bed and was kept at rest during the first five months, only being allowed to sit up an hour or two a day during the later portion of this time. From this time on she was allowed more freedom. She was given sun baths, beginning with five minutes a day, and increased to one hour. Hydrotherapy, psychotherapy, and tuberculin were also used. (See Fig. 153, page 588.)

This patient had suffered from asthma, as well as tuberculosis.

It will be noticed that she was running a temperature between 99° and 100° when she entered the institution. Her pulse ranged from 80 in the morning to 100 in the afternoon. This pulse was out of proportion to the toxemia from which she was suffering, and the degree of temperature which was present. The reason of the rapidity of the heart's action was not due to the toxemia from the tuberculosis. She was physically weak; and nervous. She was suffering from dyspnea, which was probably partly due to the shifting of the heart, it being dislocated to the right; partly to the interference with diaphragmatic action; and, partly to extensive fibrosis interfering with oxygenation. All of these factors have a tendency to reduce oxygenation, which increases acid retention and favors dyspnea, making rapid heart action necessary. I am also of the opinion that her mental depression was a considerable factor in keeping up the pulse rate.

It will be noted that there was a gradual decrease in pulse rate, which is particularly noticeable during the latter part of May. The pulse at that time, came down in the seventies, and, during the next month, came down to even the sixties. During this period the patient was making very satisfactory progress. One difficulty was to maintain even the low weight which she was carrying. She was weighing only 106 and 108 pounds, although she could easily carry 135 pounds. During the fourth and fifth month of treatment when the pulse came so low, she was suffering some from asthmatic breathing. It will be recalled, as discussed elsewhere in these pages, that asthma is due to vagus stimulation; consequently, I look upon the low pulse rate during this period as an indication of such stimulation.

It will also be noted during these two months that the temperature was more unstable. Every few days the maximum for the day would be higher than it should be. In reading a temperature chart one must not consider all of the maximum records,—it is the body of the charted curve that must be considered.

The body of her temperature curve during these two months was practically normal. During the month of June it was normal with the exception of the few days from the 8th to the 12th. During July it was above normal on the 8th and remained so until about the 20th; but it may be seen that when the temperature was highest the pulse rate was lowest. This can hardly be accounted for except as being a depression of the pulse rate due to stimulation of the vagus. On the 19th of August there was a very sharp rise of temperature which was associated with digestive disturbance, and another on the 26th, due to the same cause. This patient had considerable gastrointestinal disturbance during August and September. Her stomach was low in the abdomen and dilated; consequently it gave her annoyance at times. During this time she lost weight, and even with the most careful diet, the loss in weight persisted until she attained a low weight of 94½ pounds. This digestive disturbance, followed by loss of weight, was precipitated by worry and fretting largely induced by disappointment in finding out that what she thought was going to be a six weeks' or two months' treatment was going to require many months. She was also struggling between trying to be a Christian Scientist and the realization that she needed medical aid. The digestive symptoms abated and her weight increased until she weighed 112 pounds in November.

A very interesting rise will be noted in the temperature and pulse curves which took place on the 28th and 29th of November. Without previous warning, except for a slight amount of pain in the interscapular region, the patient was seized with a very troublesome and persistent cough, and the temperature increased from 98° in the morning of the 28th to 103° in the afternoon, and remained high for two days, when it dropped again to normal. The pulse increased from 76 on the morning of the 28th to 128 that afternoon. The severe cough continued and on the second day was accompanied by free expectoration. The amount of expectoration in October (the last measured specimen) had been 15 c.c. per day, and on the 30th of November it increased to 100 c.c. per day. The expectoration was very foul smelling, indicative of abscess.

Physical examination showed dullness in the right lower interscapular space, with signs of acute softening and cavity formation. It will be noticed that this came on without any warning whatever. The patient had just attained the highest weight at any time during her stay in the institution. On the 22nd of November she weighed 112 pounds. The pulse and temperature once more remained somewhat irregular; at the same time, were satisfactorily low during the next three weeks. On the 20th of December she again had a rise in temperature, the maximum for the day being above 101°, and reaching the same the following day. This had been preceded by one or two days of gradual elevation and by general symptoms of toxemia such as malaise, aching, nervousness, and digestive disturbances. The pulse at this time did not show a marked elevation. In accounting for this we must consider that the peripheral stimulation of the vagus by the inflammation around the abscess counterbalanced the sympathetic stimulation produced by the toxins. The patient experienced another increase in cough and expectoration, the amount reaching 120 c.c. per day. It had the same disagreeable odor as was noticed in the preceding attack on the 28th and 29th of November. At this time she also complained of a severe pain in the right shoulder and arm, and called attention to a dull pain in the interscapular region as before. Again, physical examination showed dullness and increased bubbling râles indicative of abscess. The pain continued over the right interscapular region and shoulder for about a week, when it disappeared. The amount of sputum remained about the same for a week or ten days and then gradually decreased. The patient continued to improve and by the end of January was free from all unusual symptoms and was having a normal pulse and temperature.

These two attacks of acute abscess formation require special consideration. The first one came during an epidemic of acute respiratory infections, in which the streptococcus was predominant. Within two or three days of the time that this abscess formed, another patient in the sanatorium developed a similar process. The odor of the sputum disappeared as soon as the acuteness of the process abated, and all signs passed away, leaving the tuberculous process as it was before, but with continued increased expectoration. On January 19, a short time before she left the institution, her sputum had decreased to about 70 c.c. per day.

This type of pulmonary abscess, as a rule, takes care of itself and heals after a time. In those instances, however, where a large abscess develops, involving a large portion of a lobe, usually the lower, healing is questionable.

Our method of handling such cases is very unsatisfactory. Neither medical nor surgical measures prove to be very efficacious. The best that one can do in the treatment of an abscess such as this is to use as inhalations such remedies as creosote, iodine, eucalyptol, and carbolic acid; and administer internally such remedies as creosote, guaiacol, and thiacol. When abscesses are larger, pneumothorax may be of some aid if employed while the walls are collapsible.

Laboratory Examination at Termination of Treatment.—

Sputum:	Date	Jan. 19, 1916
	Quantity (3 days)	230 c.c.
	Bacilli per field	none
Urine:	Date	Jan. 17, 1916
	Quantity (24 hrs.)	3100
	Specific gravity	1009
	Albumin	negative
	Sugar	negative
	Diazo	negative
	Indican	normal
Blood:	Date	Nov. 30, 1915
	Hb.	82
	White cells	12,150

Comment.—The interest in this patient is concentrated about the failure to obtain a diagnosis and the character of the process in the lung. At no time did we find tubercle bacilli in the sputum; yet I am reasonably certain that this case is to be classified as a case of fibroid-phthisis. This is one of the types discussed by Sir Andrew Clark in his classical monograph on fibroid phthisis.[1] The finding of bacilli is not to be relied upon wholly in diagnosis. If all sputum was examined it is probable that bacilli or splitter (Spengler) or Much's granules would be found now and then in these cases. The secretions which these patients raise probably come mostly from the bronchi. They suffer from a chronic bronchitis; and, at times, bronchorrhea. The bacilli are of low virulence, but gradually extend, invading new tissue, until the greater portion of the lung is involved. Bronchiectasis is usually found. Such cases rarely have a diagnosis made because of the failure to find bacilli. We must consider them in the same light, however, as we do those cases of fibrosis where the amount of involvement is limited, and which, sooner or later, break down with ulcerative active clinical disease. There is no difference between the small fibrosis occupying a portion of the apex, and the extensive fibrosis that destroys a lobe or a lung, except that of degree. Sooner, or later, in nearly all of these cases, bacilli will be found if the sputum is repeatedly examined. I have seen a number of cases of this type which, after a period of five or ten or fifteen years of suffering from fibrosis, chronic bronchitis, general weakness, and semi-invalidism, broke down with an active ulcerating process, during which time bacilli were found in the sputum. These patients deserve the same treatment as others. Grant that the process is not tuberculous, the patients require the same treatment as the tuberculous patients do. We know of nothing better than the ordinary tonic regime which is used for tuberculosis. The only difference that we could make for the tuberculous would be tuberculin. These patients may not need tuberculin; but, if administered, it will do them no harm. They do need every tonic fortifying measure that is of value in the treatment of tuberculosis, and such treatment should be afforded early before their physical strength is reduced and their nervous system is undermined. We must not be so fearful of treating one who has not tuberculosis that we deny assistance to an individual who has the same symptomatology as that of tuberculosis; for he requires practically the same therapy whether the etiological factor is the same or not.

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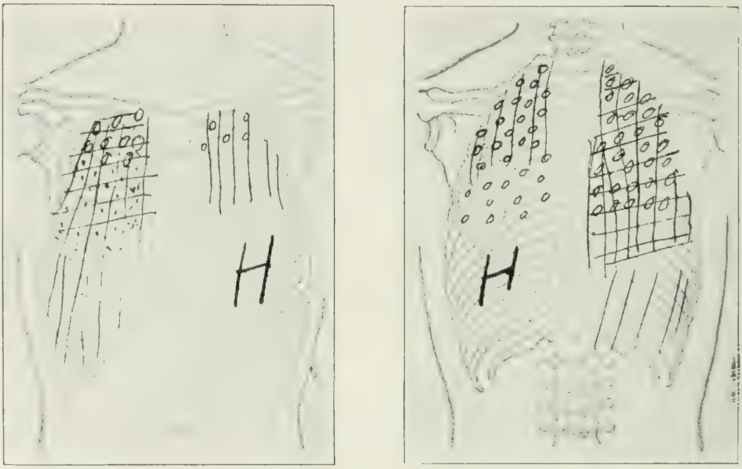
[1] Fibroid Diseases of the Lungs, Charles Griffin & Company, Limited, London, 1894.

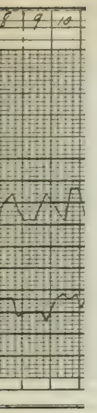
The length of time necessary to produce a favorable result in such a case is not understood sufficiently well. Such a patient must be built up physically and restored to the best nervous balance possible. This task is before the clinician at the end of years of nervous and physical exhaustion and after years of harmful psychical impression. Nerve force is to be restored, physical endurance is to be raised and psychical equilibrium

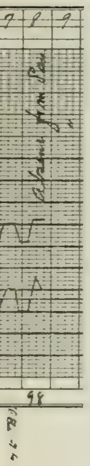


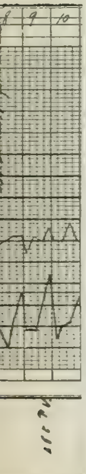
A

B

Fig. 152.—Charts of chest, Case 2657.







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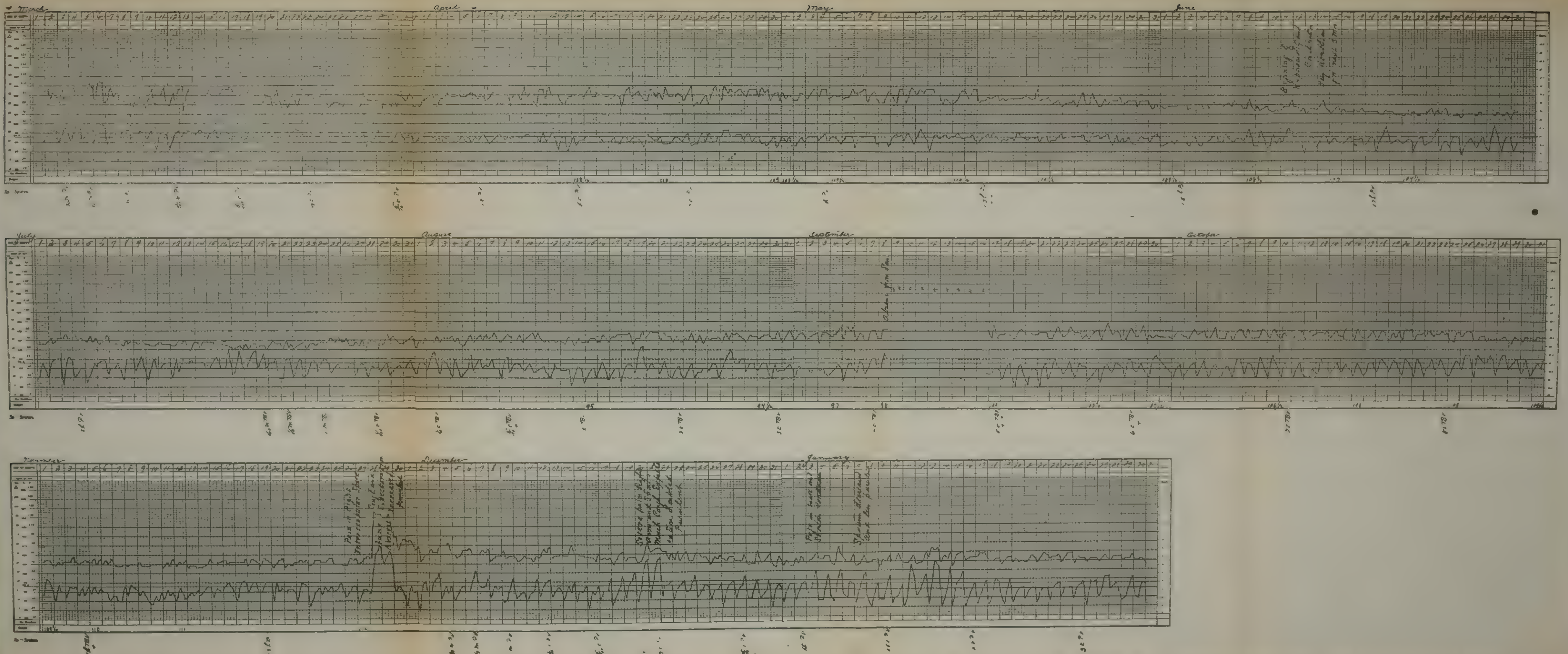


Fig. [illegible] Charts showing temperature and pulse curves, with clinical notes and doses of tuberculin, Case 2657. Increased vagus tonus begins to show in slowing of pulse in the middle of May several weeks before it manifested itself markedly in the gastrointestinal tract as a hyperacidity and spastic constipation. Upper curve, pulse; lower curve, temperature.

through re-education is to be attained, none of which can be accomplished except to a limited degree. Such a task requires months. This patient should have the assistance of strong forceful guidance with appropriate measures directed against her physical disease over a period of two or three years. Even then it would be impossible to attain more than 60 or 70 per cent efficiency.

CASE 544.

DELAYED DIAGNOSIS AND TREATMENT; CHRONIC CASEOFIBROUS TUBERCULOSIS; EXTENSIVE FIBROSIS WITH CONTRACTION OF RIGHT UPPER AND MIDDLE LOBE; EXTREME COMPENSATORY EMPHYSEMA OF LEFT LUNG; MEDIASTINUM PUSHED FAR TO RIGHT; PYOSALPINX, OPERATION; INTESTINAL INFECTION WITH OPERATION; PERITONITIS WITH ADHESIONS; DEATH FROM DILATATION OF HEART; AUTOPSY. OBSERVED FROM OCTOBER 6, 1906, TO DECEMBER 8, 1914.

A Discussion of: The Importance of Pleurisy as a Symptom of Active Tuberculosis; the Evidences of Healing; Compensation Between the Two Sides of the Thorax; and Compensation Between the Thoracic and Abdominal Cavities.

Case 554.—Housewife. Age 37. Entered the sanatorium October 6, 1906.

Family History.—Family history revealed nothing of importance.

Personal History.—Only child. Never very strong. Had ordinary diseases of childhood and made prompt recoveries. For twelve years had complained of frequent attacks of influenza. Had St. Vitus' dance at the age of twenty-four. Mother of two children, both in fair health. Had several miscarriages. Suffered much from pelvic disturbance, having had a salpingitis. Had several pelvic operations.

Tuberculous History.—Patient gave a history of having had three attacks of pleurisy; one six years and another one year previously; and one during the preceding year. She had suffered from malaise for one year. A hacking cough began one year previously, and was accompanied by slight expectoration which increased during the previous six months. Had frequently had attacks of pain in the upper part of the right chest. Had night sweats off and on for six months and had several slight hemorrhages during that time. Temperature at times had been from 101° to 103°. She suffered from shortness of breath on exertion. Had had much hoarseness and for two months complete aphonia. Digestion was poor for the preceding year. She suffered from chronic constipation, and insomnia. She menstruated profusely. Normal weight 104 pounds. Weight at the time of examination, 97½ pounds; pulse 116; temperature 99.6°.

The symptoms in this case could be tabulated according to their etiology, as follows:

SYMPTOMS DUE TO		
Toxemia	Reflex Stimulation	Tuberculous Process *per se*
Malaise	Hoarseness	Pleurisy
Nervous irritability	Aphonia	Tuberculous bronchitis
Insomnia	Hacking cough	Hemorrhage
Loss of appetite	Pain in upper portion of chest	Sputum
Loss of weight		
Rapid heart		
Night sweats		
Temperature		

Physical Examination.—Physical examination revealed severe infiltration of the upper, middle, and apex of the lower lobe on the right side, with signs of cavity at the apex; also slight infiltration of upper lobe on the left side. Heart normal. Larynx showed no signs of tuberculous infiltration, but marked disturbance in adduction, which accounted for the hoarseness. The condition of the lung on entrance is shown in Fig. 154, and at death in Fig. 155, page 594.

Laboratory Examination.—

First Entrance

Sputum:	Date	Jan. 22, 1907
	Quantity (24 hrs.)	sample
	Bacilli per field	few
Urine:	Date	Apr. 22, 1907
	Quantity (24 hrs.)	1100
	Serum albumin	negative
	Serum globulin	negative
	Sugar	negative
	Diazo	negative
	Indican	normal
	Specific gravity	1010

Second Entrance

Sputum:	Date	Oct. 8, 1910
	Quantity (24 hrs.)	10 c.c.
	Bacilli per field	5
Urine:	Date	Oct. 8, 1910
	Quantity (24 hrs.)	1550
	Specific gravity	1016
	Serum albumin	negative
	Serum globulin	negative
	Sugar	negative
	Diazo	negative
	Indican	normal
Blood:	Date	Sept. 7, 1910
	Hb.	85
	White cells	6,200
	Arneth index	80
	Lymphocytes	1200

Treatment.—Patient entered the Pottenger Sanatorium and was placed in the open air and given an abundance of food, as overfeeding was the rule at that time. A cold sponge bath was given each morning. Heliotherapy in the form of a concentrated sun bath from a large mirror, in which the heat rays were cut off by blue glass for a period of forty minutes each day, was given. Tuberculin was given in gradually ascending doses; exercise was suited to the patient's strength and condition of the lung, and the patient was kept cheerful and optimistic.

The patient left the sanatorium after eight months with temperature 99°, pulse 90, weight 109.6 pounds. The cavity at the right apex had dried and bacilli were absent. The heart was shifted slightly to the right. After leaving the sanatorium the pelvic trouble became acute and considerable operative interference was resorted to, which resulted in a very serious general pyogenic infection which almost cost the patient her life and left her with a rectovaginal fistula.

The patient remained well for two and a half years during which time she did her own housework and took upon herself duties which were too arduous, and, on October 7, 1910, she returned a second time with renewed activity in the upper half of the right lung, scattered foci through the lower lobe and marked infiltration in the larynx. She was also suffering from obstinate constipation and symptoms which led us to suspect tuberculosis of the intestines. Temperature was 99.6°, pulse 90, weight 94½ pounds.

The patient was placed on the same general treatment. She remained in the institution for ten months, leaving August 30, 1911. During this period the activity in the lung was considerably lessened and marked contraction of the right lung had occurred. The left lung remained healed and took on a moderate degree of compensatory emphysema. The bowel condition did not yield. At the time of discharge her temperature was 99.4°, pulse 80, and weight 89 pounds. She showed slight activity in the right lung. The cavity at the apex, however, remained dry.

Operation for Tuberculous Enteritis.—Shortly after this owing to the fact that the tuberculous condition in the bowel, as near as we could tell, seemed to be largely confined to the region of the appendix, an operation was advised. Upon opening the abdomen we found a tuberculous appendix and a very large tuberculous ulcer in the head of the cecum near the base of the appendix, the head of the cecum being very much thickened.

There was also a large ulcer in the ileum about twelve inches from the ileocecal valve. Owing to the fact that the patient was taking the anesthetic badly, it did not seem best to do a resection. The ulcer in the ileum was removed by a V-shaped incision, and the ends of the gut brought together. The ulcer in the head of the cecum was treated by turning it in by means of a purse-string suture so that if a perforation occurred (we had some fear of this owing to the depth of the ulcer and the friable nature of the tissues) the escape of the contents into the peritoneal cavity would be prevented.

The patient recovered slowly from the operation and then spent two or three months in Arizona. She suffered some from pain about the seat of the operation for a time and had considerable disturbance which seemed to be a result of the ulcer in the cecum; but this finally disappeared, although the patient always suffered from obstinate constipation and gas pains, which may be explained by the adhesions found at autopsy.

Later History.—For the next three years I saw the patient occasionally, and during most of this time she was in a condition of semi-invalidism, suffering from weakness, obstinate constipation and gas, and from a gradually increasing dyspnea.

During this time the contraction in the right lung was continuously increasing and the left lung was taking upon itself an increased compensatory emphysema. The heart and mediastinum were gradually pushing to the right.

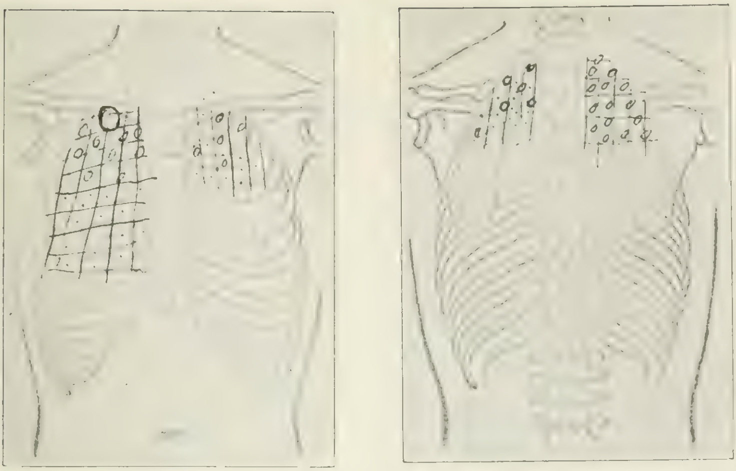
I was called to see her about one month before her death. Her dyspnea was increasing quite markedly. At this time she was using all the auxiliary muscles of respiration in breathing. She also complained of extreme weakness, disgust for food, of seeing spots before her eyes, and, at times, of an almost unendurable dyspnea. Physical examination showed the heart to be very large and moved far over to the right side, and the pulse rate very rapid. Temperature was normal. I made a diagnosis of dilatation of the heart and put her on appropriate treatment. There was no relief in her condition until her death on December 8, 1914.

Autopsy.—On opening the chest we found the trachea pushed over two inches to the right of the median line. The heart was very large and occupied the center of the chest cavity. The pericardium stretched over it tightly.

The upper part of the right lung was a contracted mass about the size of one's fist. At the extreme apex was a cavity which at one time had been probably the size of a hen's egg. The walls were smooth and dry and the cavity was surrounded by connective tissue one-fourth of an inch thick. It was compressed so that its walls were almost in apposition. The rest of this apex contained numerous small cavities and large amounts of dense fibrous tissue. It had no functionating power.

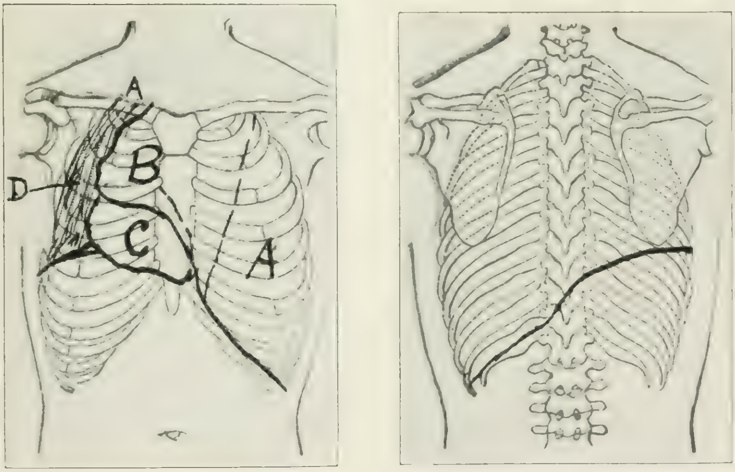
The middle lobe was also the seat of considerable fibrosis, was very much contracted and had practically no functionating power.

The lower lobe on the anterior surface was a dense fibrous mass extending from the lower border of the second rib to about the lower border of the fourth rib, its median border being in the mammary line. Posteriorly, the apex of the lower lobe was pushed upward and contained several small suppurating cavities surrounded by dense fibrous tissue. The rest of the lobe was markedly emphysematous, although it also contained a great deal of scattered fibrous tissue, which had resulted from healed tubercles.



A   *B*

Fig. 154.—Charts of chest, Case 544, at beginning of treatment.



A   *B*

Fig. 155.—Charts of chest, Case 544, prior to death: *A*, lower left lobe; *B*, upper left lobe; *C*, heart; *D*, right lung.

The pleura on the right side was thickened and adherent from the top to the bottom.

The upper lobe of the left lung contained numerous fibrous nodules resulting from healed tubercles; but, the entire lung was markedly emphysematous. The upper lobe had pushed to the right through the anterior mediastinum so that the right border above the heart was three inches to the left of the median line. The lung also extended downward so that it filled the entire pleural space. At the apex the emphysema had reached such a high degree that it had pushed beyond the contracting fibrous tissue so that distinct lobes were formed, the sulci between them being half an inch or more in depth. This distortion is shown in Fig 40, Vol. I, page 286.

The pleura on the left side was only slightly thickened.

The diaphragm on the left was lower than normal, being pushed down by the emphysematous lung, while on the right it was much higher than normal, having followed up the retracted lung. It reached to about the third interspace.

In the left pleural cavity there were several ounces of fluid which was probably a result of the failing heart.

On opening the abdomen we found the ascending and transverse colon in the pelvis, the stomach three inches below the umbilicus, and the intestines bound down firmly by adhesive bands which had resulted from the peritonitis at the time of her pelvic infection.

The right kidney was badly prolapsed. The left kidney was in normal position.

The liver was large and had pushed high up on the right side following the diaphragm so that almost a new lobe had formed to fit itself to the contour of the shrinking lung. The left lobe was also double its normal size.

The cecum showed a decided pouching and its walls were as thin as paper. No evidence of active tuberculosis could be found in the intestines.

On opening the cecum we found that the ulcer which had been turned in at the time of the operation had healed and nothing remained except a mass of fibrous tissue.

First Discharge

Sputum:	Date	Jan. 29, 1908
	Quantity (24 hrs.)	2 c.c.
	Bacilli per field	negative
Urine:	Date	Jan. 29, 1908
	Quantity (24 hrs.)	1600
	Serum albumin	negative
	Sugar	negative
	Diazo	negative
	Indican	slightly increased

Second Discharge

Sputum:	Date	June 21, 1911
	Quantity (24 hrs.)	20 c.c.
	Sediment vol.	4
	Bacilli per field	25
Urine:	Date	July 22, 1911
	Quantity (24 hrs.)	1600
	Specific gravity	1009
	Serum albumin	negative
	Serum globulin	negative
	Sugar	negative
	Diazo	negative
	Indican	negative
Blood:	Date	May 22, 1911
	Hb.	90
	White cells	8700
	Arneth index	72
	Lymphocytes	1300

Comment.—This case is extremely interesting from many standpoints.

From the Diagnostic Standpoint.—Pleurisy was present in this patient six years before the diagnosis was made and again one year, yet it was not heeded. Pleurisy is due to a tuberculous process in such a large percentage of cases that tuberculosis should always be ruled out before a diagnosis is made. Dry pleurisy has tuberculosis for its etiology just as often as pleurisy with effusion. When we have active pleurisy it means that there is a pleural or subpleural tuberculosis present which is in a state of active inflammation. It is not necessary to wait for this to spread. The patient should be treated for tuberculosis at once, the same as though the disease were in the lung proper.

This patient had a cough, and showed a general debility, with occasional spitting of blood a year before the diagnosis was made.

From the Standpoint of Treatment.—When this patient was put under proper treatment she responded at once and after a few months had shown an arrestment of the disease with a healing of a large cavity; and, it was interesting to note, that at the time of the autopsy eight years later, this cavity still remained dry and healed. This patient's resisting power was so much increased and her immunity to her disease was so raised that although her arrestment was so recent, still she went through her severe pelvic disturbance with accompanying operations and septicemia with very little activity recurring in the lung.

From the Standpoint of Compensation Within the Thorax.—The fact is not sufficiently appreciated that every destruction of tissue within the thorax is compensated for by the remaining tissues. In this case the right lung was reduced to half its normal size. The upper lobe was contracted to a small fraction of its normal size, and the lower lobe was very much reduced by new connective tissue formation; but the part that was able, took upon itself an intense degree of enlargement and filled as much of the space as it could.

That portion of the left lung which had not been converted into fibrous tissue in the healing of the tuberculous process, took upon itself an enormous hypertrophy, almost doubling in size; completely filling the complimentary pleural space, forming a new lobe and pushing over a distance of three inches to the left of the median line above the heart.

The effect on the mediastinum, including the heart, is also extremely interesting. The posterior portion of the mediastinum is fastened securely so that it cannot move to any great extent, particularly to the right, but the anterior portion of the mediastinum, including the heart, can push far over as it did in this case, provided that the pericardium is sufficiently large to allow this to occur. The right border of the heart lay within three-fourths of an inch of the ribs on the right axillary line, there being a fibrous tongue of the right lung between it and the chest wall. The pushing of the heart over to this side widened the curve of the arch of the aorta, and as the mediastinum was pushed far over out of its normal position, there was considerable drawing upon the tissues about the root of the lung. Particularly was this noticeable on the recurrent laryngeal. This patient had, as so many patients have under similar circumstances, the same brassy cough that accompanies aneurism.

It is extremely interesting to see the way that patients can accustom themselves to such marked displacements. With the trachea two inches to the right, with the arch of the aorta greatly widened, with the heart pushed more than two inches to the right of its normal position, this patient was still able to live in fair comfort during a number of years.

Another interesting feature in this case is the pericardium. In opening the chest we found the pericardium stretched tightly over the heart. The probabilities are that the heart dilated as far as the pericardium would permit. The size of the pericardium is a very important factor in the contractions which occur in advanced tuberculosis accompanied by shifting of the mediastinum. If the pericardium is large the heart shifts easily and accommodates itself to the changed conditions better than when the pericardium is small.

Compensatory Changes Between the Thoracic and Abdominal Cavities.—Not only do we have compensatory changes in the thorax itself, but also between the abdominal and thoracic cavities. It will be noticed that the right lung, even after that portion which was able to hypertrophy had done so, and after the left lung and mediastinum had pushed over into the right thoracic space and had occupied all the space that they possibly could, still the original space was far from being occupied. This was compensated for by the diaphragm pushing up following the contracted right lung and the liver enlarging, apparently forming a new lobe, to occupy the space from which the lung had withdrawn.

On the left side we notice that the abdominal cavity was encroached upon because of the fact that the left lung had taken upon itself such an inordinate degree of emphysema that it had pushed the diaphragm down below its normal position.

CASE 2552.

ILLUSTRATING CHRONIC FIBRO-ULCERATIVE TUBERCULOSIS: COMPLICATED BY TUBERCULOUS LARYNGITIS, AND TUBERCULOUS OTITIS; ENDOCARDITIS; ACUTE DILATATION OF THE HEART; ASTHMA; ASTHENICA UNIVERSALIS; IMPROVEMENT; TEMPORARY ARRESTMENT; DEATH. OBSERVED FROM DECEMBER 22, 1914, TO JULY 8, 1915.

A Discussion of: The Relationship of Persistent Bronchitis to Tuberculous Infection; Widespread Physical Signs Without Correspondingly Severe Symptoms; Asthma With Resulting Cardiac Dilatation and Treatment of Both Conditions; the Effect of Periodical Activity in a Tuberculous Process Over a Term of Years Upon Both the Nervous System and the Physical Being; Relationship of Clinical Symptoms to Pathological Healing; and Length of Time Required for Cure.

Case 2552.—Male. Age 18 years. Entered the sanatorium December 22, 1914.

Family History.—Negative as far as tuberculosis is concerned. Father died at age of 49 of peritonitis complicating gastric ulcer. Mother died at age of 52 of angina pectoris. One maternal aunt and one maternal uncle died of tuberculosis.

Personal History.—Patient always delicate. Had measles, mumps, chickenpox. Recovered from all promptly. During childhood patient suffered from frequent attacks of tonsillitis. Had the protruding portion of the tonsil clipped off, but tonsillitis continued. In 1909 it was found that he had developed a heart murmur, although the time when the acute endocardial trouble began is not known. In 1908 he had an operation on his nose for straightening the septum. The bases of his tonsils were enucleated in 1910.

Tuberculous History.—Patient had had bronchitis from the time he was four years of age. While he had improved at times, he had never been free from a slight hacking cough.

Seven years prior to entry his bronchitis was so severe that he was sent to Florida for the winter and was in bed much of the time. At that time tuberculosis was suspected, but tubercle bacilli were not found in the sputum. Two years later he was sent to Florida again under the same conditions. After that his attacks were less severe. In May, 1914, the patient was run down and felt below par for a time, and on December 10, 1914, after having an attack of what seemed to be a cold, for two months, bacilli were found in the sputum.

During the two months prior to his entering the sanatorium his endurance declined, he seemed to be more tired than usual and had a renewed attack of bronchitis. He lost a little in weight, although his appetite remained good. Slight hoarseness also appeared. The irritation in his throat increased and his cough became somewhat more marked. His expectoration increased to about two ounces per day. His sputum showed flecks of blood occasionally during this time, and he had some pleural pain in the upper part of the right chest.

The symptoms from which he suffered may be classified as follows, according to their etiology:

SYMPTOMS DUE TO		
Toxemia	Reflex Stimulation	Tuberculous Process *per se*
Malaise	Hoarseness	Tuberculous bronchitis
Lack of endurance	Hacking cough	Bloody expectoration
Loss of weight		Sputum
Fever		Pleurisy
Increased pulse rate		

Examination.—Patient sallow, nutrition poor. Temperature 100.6° at 4:00 P. M. Pulse 96. Blood pressure 106 on the left side. Height 6 feet 2 inches, weight 116 pounds. Slight dyspnea on exertion.

Condition of the Muscles and Subcutaneous Tissue.—The condition of the muscles and subcutaneous tissue is shown in the following table in which the — sign is used to indicate degeneration, and the + to indicate spasm. The degree of spasm and degeneration is indicated by the number of signs; one meaning slight; two marked; and three very marked.

	RIGHT		LEFT	
	Degeneration	Spasm	Degeneration	Spasm
Sternocleidomastoideus	— —	+	—	+
Pectoralis	— —	+	—	+
Trapezius	— —	+	—	+
Levator anguli scapulæ	— —	+	—	+
Rhomboidei	— —	+	—	+
Degenerated subcutaneous tissue	To base anteriorly and posteriorly		Slight to fourth rib anteriorly and middle of scapula posteriorly	
Lessened motion	Lags some		Far more than right	

Palpation of Total Resistance.—Right.—Increased density to the third rib. From the third rib to base increased tension and a density less than normal, indicative of emphysema. Left.—Increased density to base on left.

Suggested Diagnosis from Inspection and Palpation.—Extensive chronic fibroid tuberculosis of both lungs. Renewed activity in both lungs, more extensive on left than on right. Emphysema right lower lobe.

Examination of Other Organs.—Epiglottis, both cords and arytenoids moderately infiltrated. Otitis media, probably of a tuberculous nature affecting left ear; drum perforated. Endocarditis.

Percussion.—Right.—*Anteriorly.*—Moderate dullness to the third rib. *Posteriorly.*—Moderate dullness to the middle of the scapula, except immediately below the apex there was a small area of tympany, indicative of cavity. There was hyperresonance from the third rib and the middle of the scapula to the base. Left.—*Anteriorly.*—Marked dullness over the apex, decreasing to moderate dullness at the fourth rib, with slight impairment from there to the base. *Posteriorly.*—Moderate dullness to the lower third of the scapula.

Auscultation.—Right.—*Anteriorly.*—Slightly rough harsh inspiration with slightly rough harsh prolonged expiration from the apex to the third interspace. Moderate numbers of râles down to second interspace on ordinary inspiration. *Posteriorly.*—Same to the middle of the scapula. The respiratory note was exaggerated and prolonged from the above limit to the base.

Near the apex there was a distinct blowing expiration indicative of cavity. Numerous medium râles were brought out on coughing down to the middle of the scapula and numerous fine dry râles in the area immediately below. LEFT.—*Anteriorly.*—Rough harsh inspiration with rough harsh prolonged expiration from the apex to the fourth rib. Many medium râles were heard on ordinary inspiration down to the third interspace. *Posteriorly.*—Rough harsh inspiration with rough harsh prolonged expiration to the lower third of the scapula, the degree of roughness and harshness being much more extreme near the apex, but diminished below. Many medium râles were heard on coughing to the upper third of the scapula.

Examination of the heart showed an organ above normal in size, placed low in the chest, the apex being in the sixth interspace, and the organ, as a whole, being moved about one inch to the left. The heart sound at the apex was accompanied by a musical murmur. This murmur could be heard on the left from the second interspace to the base of the lung both anteriorly and posteriorly, but seemed strongest at the apex. It was heard best at the end of expiration and disappeared on deep inspiration. It was impossible to distinguish the two sounds at the apex. Both aortic sounds were distinct, and the second aortic accentuated.

Laboratory Examination.—

Sputum:	Date	Dec. 23, 1914
	Quantity (24 hrs.)	55 c.c.
	Sediment vol.	7
	Bacilli per field	1
Urine:	Date	Dec. 23, 1914
	Quantity (24 hrs.)	1300
	Specific gravity	1020
	Serum albumin	slight trace
	Serum globulin	negative
	Sugar	negative
	Diazo	suggestion
	Indican	slightly increased
Blood:	Date	Dec. 24, 1914
	Hb.	80
	White cells	11,650
	Arneth index	60
	Lymphocytes	2000
	Neutrophile stippling	slight

Diagnosis.—General fibroid tuberculosis of many years' duration, with renewed activity at the present time in both lungs. Cavity at right apex, marked contraction through the left lung with the beginning of softening. Compensatory emphysema in right lower lobe. The condition of the chest is shown in Fig. 156.

Prognosis.—The prognosis was unfavorable. Prognosis in a case like this must be modified by many conditions. In the first place, the general build and lack of resisting power of the patient makes any pulmonary involvement more grave. The fact, however, that the disease had probably existed for a long time, shows that at least the original disease was not of a very virulent nature.

Analysis of the Case.—The previous history of this case is extremely interesting. A poorly developed individual, suffering from bronchitis from the time he was four years of age would suggest, today, the possibility of an active disease in the bronchial glands, especially when the after history is taken into consideration. At eleven and thirteen years of age the attacks of bronchitis became so severe that tuberculosis was suspected, although tubercle bacilli were not found. The patient was sent to Florida for the winters where he improved and recovered his health to such an extent that he had no further outbreak until the present time. The change wrought in resisting power, together with the climatic change, was sufficient to cause a temporary arrestment of the trouble.

In the light of our examination we are led to suppose that probably at this time the disease had already entered the lung. Our reasons for such a supposition are that although from that time until the present there had been no further severe outbreaks of his bronchitis yet his slight hacking cough had persisted the same as prior to that time; and, at the time of our examination, we found abundant evidence of fibroid tissue in both lungs.

The onset of the present attack was sudden. Without any particular warning the patient had symptoms of what seemed to be a cold. The cough increased, the expectoration became more profuse, fever developed, and the patient lost strength. After these symptoms had persisted for nearly two months, bacilli were found in the sputum.

This is a typical picture of old chronic fibroid tuberculosis, taking upon itself increased activity with necrosis, caseation and ulceration following. Whether the patient suffered from a genuine attack of bronchitis, and this was the factor which produced the inflammation in the seat of his old infection or whether for some unknown reason the bacilli became active and started to multiply and the symptoms were primarily due to such activity, it is impossible to tell.

The fact that there is evidence of cavity formation in the posterior portion of the right lung would indicate that the destruction had gone on rather rapidly. The fact that the character of breathing was so changed over both lungs as to show a new infection accompanied by considerable collateral inflammation of the tissues, would indicate that a greater virulence had developed in the process.

Treatment and Course of Disease.—The temperature and pulse curves are shown in Fig. 157. Upon entering the institution it will be noted from the first chart that the patient was running a temperature of more than 100. Prior to this time the temperature had been still higher. The pulse rate was also above 90. Other symptoms also belonging to the syndrome of toxemia were present. The patient had a variable appetite, had lost some weight, tired easily and showed mental depression.

The cause of these symptoms was partly the activity in the lung; partly wrong methods of living; the exercise that the patient had been taking at a time when he should have been at rest; and partly the disturbance of his sympathetic nervous system, due to his mental depression. These facts were indicated by the course of the temperature and pulse during the next few months. The pulse rate had an added element beyond that of sympathetic stimulation in the fact that he had suffered from endocarditis, with some myocardial degeneration. It will be noticed that the temperature and pulse both began to decline, and, by the middle of the second month, his temperature approached the normal; and, after that, there was a rise on one or two occasions, but only temporarily. This fact requires some explanation because of the severity of the symptoms and the signs of widespread activity in the lungs.

It will be noted that on physical examination there were many medium râles in the upper portion of both lungs, with evidence of cavity in the right and much contraction in the left. These, with a temperature ranging from 100° to 101°, would indicate a very marked activity and considerable collateral inflammation and necrosis.

The fact that all symptoms disappeared shortly after putting the patient under treatment and at rest would indicate that whatever active inflammation there was in the lung, it was having free drainage, because the patient soon became free from his toxic symptoms. The probabilities are that many of these râles were extrapulmonary in character, and possibly, of pleural origin. Some of them also originated in the bronchi and not in the tuberculous process itself.

If one were to look at the charts they would consider that there was nothing interesting in them after the first of March. From that time on the temperature was normal, and the pulse was gradually approaching the normal, reaching it in the early part of June. The patient during this time was gaining in weight and improvement was satisfactory in every respect.

The sharp rise of temperature and pulse which was shown on the 26th day of February had nothing to do with his tuberculous process. The same is true of the slight rise in temperature, and the marked rise in pulse on the 20th and 22nd of May. These were due to attacks of asthma. The patient had, during preceding years, suffered from occasional attacks of asthma, and on these two dates he had sharp attacks which showed their effect particularly on the pulse. At this latter time there was also an acute dilatation of the heart, the patient suffered from sharp precordial pain, from anxiety, distress and insomnia, loss of appetite and weight. Physical examination revealed the heart much enlarged, with dilatation of the right ventricle. After rest in bed these symptoms gradually disappeared.

Where a sound heart would have stood the attack of asthma with very little disturbance, this heart dilated markedly and gave all the symptoms which usually accompany this condition. The treatment of this dilatation of the heart should be mentioned. The patient was kept extremely quiet. An ice pack was kept over the heart. He was given some morphia and digitalis. He was also given atropin and adrenalin for his asthma; the atropin to act directly upon the vagus nerve and relieve the bronchial spasm,—the adrenalin to stimulate the sympathetics and oppose the action of the vagus.

The following month the patient remained at rest and the temperature and pulse were practically normal. The heart regained its tone and the patient again showed satisfactory improvement.

He left the institution about the middle of July. I cannot give in detail the after course of the disease, except to state that he took more exercise, was less conscientious in his treatment, and later developed an influenza with mastoiditis. Shortly after this he developed a pneumonia and died. The death of this patient was, in all probabilities, due to dilatation of the heart. The heart under normal conditions had all the strain that it could stand and gave away under the added pulmonary embarrassment.

Laboratory Examination at Termination of Treatment.—

Sputum:	Date	June 11, 1915
	Quantity (24 hrs.)	20 c.c.
	Bacilli per field	3
Urine:	Date	June 11, 1915
	Quantity (24 hrs.)	1600
	Specific gravity	1015
	Albumin	negative
	Sugar	negative
	Diazo	negative
	Indican	slightly increased
Blood:	Date	June 11, 1915
	Hb.	90
	White cells	10,050

Comment.—This case is cited in order to illustrate several different things.

1. How tuberculosis will go on and involve a large pulmonary area before active necrosis occurs. This patient had had his disease from the time that he was a little child. It had produced its serious changes in the lung tissue, had caused marked contraction of the left lung, and compensatory emphysema in the lower portion of the right before any symptoms of active necrosis appeared. At this time, suddenly, without loss of weight,—and without previous warning, the patient developed symptoms of activity,—what seemed to be a cold. This was followed by temperature and expectoration; and physical examination revealed a cavity in the upper portion of the right lung, with widespread symptoms of activity through the left lung.

This patient belonged to the asthenic type. He was more than six feet tall, and weighed less than 120 pounds. He was deficient in both physical and nervous vigor, and no matter how successful the treatment of his active tuberculosis at this time might have been, the damage was already done and he could never have become more than an invalid. The time to have treated this patient was early in his childhood before the disease had involved the lung so extensively.

I cannot emphasize too strongly the importance of recognizing and treating patients who are suffering from fibroid tuberculosis, even although not accompanied by signs of necrosis and marked symptoms of active disease.

2. The next point of interest is the manner in which sympathetic stimulation,—high pulse rate, high temperature curve, digestive disturbances, and mental depression, are relieved by proper treatment and rest.

3. Another very important lesson to be drawn from this history, is the fact that the temperature and pulse curves and the symptoms which were present after the middle of the second month, in no way indicated the seriousness of the disease. If one were to pass upon the clinical condition by the temperature and pulse, without knowing the accompanying history, he would pronounce the patient well during June; but such is not true. There was never a time during this patient's stay in the institution when his health and life were not jeopardized by the tuberculous process.

While the last month's chart is practically normal, as far as temperature and pulse are concerned, yet this patient was in a serious condition. Had the disease progressively improved, it would have required anywhere from one or two to three years to have secured a conversion of the tuberculous infiltration into scar. We cannot base our opinion of the presence or absence of activity in the lung upon the temperature chart. Pathological activity is present until the whole process is converted into scar, and the pathological activity is the thing that must be considered in giving an opinion as to whether the tuberculous process is cured. The symptoms of tuberculosis disappear long before healing has occurred. The symptoms of toxemia disappear early; so may the reflex symptoms, such as hoarseness, tickling in the larynx and cough, unless the disease is very active and widespread. Pain in the shoulders may remain longer.

This relationship between clinical activity and pathological activity cannot be too strongly emphasized. It is at the bottom of much of our misconception regarding tuberculosis. As long as the patient looks well and is not suffering from symptoms of toxemia, he is apt to be considered as well; but, as this case illustrates so well, pathological activity may be present for many years without the production of recognizable clinical symptoms.

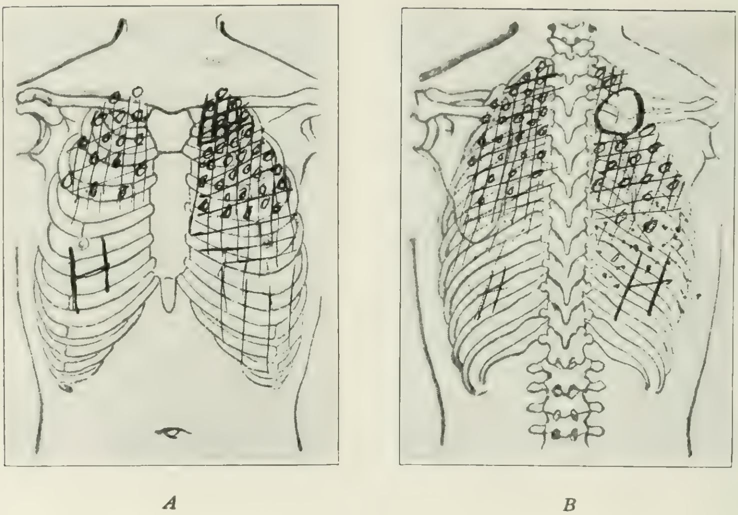


Fig. 156.—Charts of chest, Case 2552.

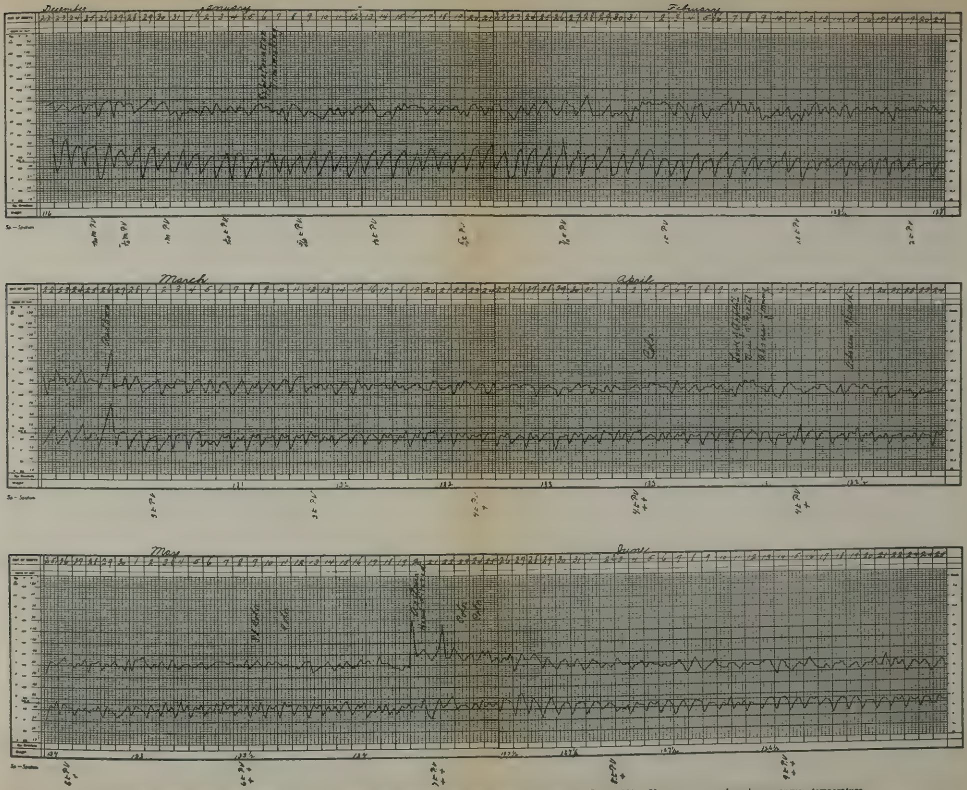


Fig. 157.—Charts showing temperature and pulse curves, with clinical notes and doses of tuberculin, Case 2552. Upper curve, pulse; lower curve, temperature.

CASE 1828.

DELAYED AND NEGLECTED DIAGNOSIS: CHRONIC CASEOFIBROUS TUBERCULOSIS; SHIFTING OF MEDIASTINUM; COMPENSATORY EMPHYSEMA; COMPLICATING HEMORRHAGES, PNEUMOTHORAX, INTESTINAL INFECTION AND GASTRIC DILATATION; MARKED IMPROVEMENT FOLLOWED LATER BY DEATH. OBSERVED FROM APRIL 13, 1912, TO DECEMBER 12, 1913.

With a Discussion of the Earlier History; Tuberculous Pneumonia Followed by Rapid Destruction of Lung Tissue; Pneumothorax; Hemorrhage; Dilatation of the Stomach; Suspected Intestinal Infection.

Case 1828.—Housewife. Age 40. Entered the sanatorium April 13, 1912.

Family History.—Father died of apoplexy at the age of 61. Mother living and well. No tuberculosis in the family. Was the sixth of ten children all of whom are living and well, except two brothers, who died in infancy.

Personal History.—Measles and chicken pox as a child. Broke down in school at the age of nine years.

Tuberculous History.—Pleurisy on the right when ten years of age.

Patient had slight hacking cough in October, 1910, for which she consulted a physician in November, 1910. This cough was followed by expectoration in February, 1911. During this period the patient had malaise, loss of appetite and weight. The cough and expectoration continued periodically until the patient consulted me in April, 1912. In February, 1912, however, she had a more profuse expectoration and some fever. In June and November, 1912, the patient had hemorrhages. Had considerable pleurisy over the right chest from May, 1910, until the time of consulting me. The patient also complained of hoarseness and some pain in the throat. The patient had had a markedly disturbed appetite during the four preceding years. She menstruated regularly until October, 1911, when menses ceased.

The symptoms in this case could be tabulated according to their etiology, as follows:

SYMPTOMS DUE TO		
Toxemia	Reflex Stimulation	Tuberculous Process *per se*
Malaise	Hoarseness	Tuberculous bronchitis
Loss of appetite	Cough	Pleurisy
Loss of weight		Hemorrhages
Temperature		Sputum (bacillus-bearing)

Examination.—The patient is well nourished, but decidedly sallow. Pulse 108. Temperature 102°.

Condition of the Muscles and Subcutaneous Tissue.—The condition of the muscles and subcutaneous tissue is shown in the following table, in which the — sign is used to indicate degeneration, and the + to indicate spasm. The degree of spasm and degeneration is indicated by the number of signs; one meaning slight, two marked, and three very marked.

	RIGHT		LEFT	
	Degeneration	Spasm	Degeneration	Spasm
Sternocleidomastoideus	— —	+		+ +
Pectoralis	— —	+		
Trapezius	— —	+		+ +
Levator anguli scapulæ	— —	+		
Rhomboidei	— —	+		
Degenerated subcutaneous tissue	Over entire right lung			
Lessened motion	Marked entire right lung			

Palpation of Total Resistance.—RIGHT.—*Anteriorly.*—Marked density over the right lung, this being extremely marked over the upper lobe except over the first and second interspace, where there was lessened resistance, indicative of cavity. *Posteriorly.*—Marked resistance over the entire lung. This was particularly marked to the lower angle of the scapula except in the upper portion of the interscapular space there was a marked lessening of resistance, indicative of cavity. LEFT.—*Anteriorly.*—The resistance over the left lung was slight at the apex, while the tension over the remaining portion was marked, and the total resistance was less than normal, indicative of emphysema. *Posteriorly.*—Moderate resistance above the spine of the scapula and increased tension with decreased resistance over the remaining portion of the lung indicative of emphysema.

Suggested Diagnosis from Inspection and Palpation.—Marked infiltration of right lung, with cavity near apex. Thickened pleura at right base. Marked infiltration of left apex with compensatory emphysema throughout left lung

Percussion.—Percussion confirmed the findings on palpation. RIGHT.—*Anteriorly.*—Dullness over the entire right lung, quite marked to the fourth rib, except in the first and second interspace where there was slight tympany confirming the suggestion of cavity found on palpation. *Posteriorly.*—Dullness to the base of the right lung, quite marked from the apex to the lower angle of the scapula, with tympany in the superior portion of the interscapular space. LEFT.—*Anteriorly.*—Slightly impaired resonance at the apex with hyperresonance over the remaining portion of the lung. *Posteriorly.*—Slight impairment of the note above the spine of the scapula and marked hyperresonance through the remaining portion of the lung. Percussion also confirmed the displacement of the heart showing it to be shifted one inch to the right.

Auscultation.—RIGHT.—*Anteriorly.*—Decidedly rough harsh inspiration and prolonged expiration with many medium râles over the upper lobe to the fourth rib with blowing expiration and whispering voice in the first interspace; also a rough harsh note with prolonged expiration and a lesser number of râles to the base. *Posteriorly.*—Rough harsh inspiration with prolonged blowing expiration and whispering voice above the spine of the scapula with rough harsh inspiration and prolonged expiration from that to the base. Many medium râles were found particularly from the apex to the lower angle of the scapula, some to the base. The breathing was very weak over the entire right lung giving evidence of pleural thickening. LEFT.—*Anteriorly.*—Slightly rough harsh inspiration and slightly harsh prolonged expiration, accompanied by a few fine râles above the second rib. *Posteriorly.*—Same above the spine of the scapula. The entire portion of this lung showed a very marked prolonged expiration indicative of emphysema.

Laboratory Examination at Beginning of Treatment.—

Sputum:	Date	April 14, 1912
	Quantity (24 hrs.)	75 c.c. mucopurulent
	Bacilli	5 to the field
	Sediment vol.	20 c.c.
Urine:	Date	April 14, 1912
	Quantity	950 c.c. per day
	Albumin	negative
	Sugar	negative
	Diazo	positive
	Indican	normal
	S. G.	1014
Blood:	Date	April 15, 1912
	Hemoglobin	85 %
	Leucocytes	12,600
	Arneth index	85
	Lymphocytes	1400

Diagnosis.—Widespread tuberculous infection involving the entire right lung. Very severe, actively destructive, process with cavity formation going on in the upper part of the right lung; infiltration and marked collateral inflammation in the entire upper lobe and part of the lower lobe; scattered infiltration to the base with marked pleural thickening. Also moderate infiltration of the upper portion of the left lung with slight collateral inflammation. Marked emphysema over the entire left lung. The condition of the lungs is shown in Fig. 158, at end of description.

Prognosis.—The prognosis in cases like this, as far as cure is concerned, is almost wholly hopeless. It is possible that the right lung may be cleared of its necrotic material, and that the remaining portion may become a fibrous mass. It is also possible for the process in the left to become arrested. In event of these changes occurring, the mediastinum would shift further to the right, if its attachments would permit it, and such cavities as fail to dry out would remain and continue secreting. Should such a result be obtained the patient would have used up her reserve lung and heart power, and consequently be unable to meet extra demands. She might be comfortable when at rest, but dyspneic on exertion.

Analysis of the Case.—The first clinical signs of tuberculosis shown by this patient go back to the pleurisy on the right at the age of ten years. From that time on, no further symptoms developed until the fall of 1910, at which time the usual symptoms indicative of slight involvement appeared,—dry hacking cough with slight malaise and slight disturbance on the part of the appettite and weight. These symptoms persisted, as they so often do, for months before the patient began to have increased cough and expectoration. The pathological changes that were occurring in the lung during this time were probably a gradual extension of the disease from the early foci by way of the lymph channels; and the multiplication of bacilli producing necrosis, caseation, and, later, excavation. The diagnosis should have been made in October at the beginning of the clinical symptoms.

Following the increased expectoration, which occurred in February, 1912, there was an amelioration of all symptoms. The probabilities are that the areas where necrotic masses were present were expelled, and this gave the patient temporary relief. The disappearance of symptoms following such attacks as this is very apt to be taken by the patient as meaning a cure. On the contrary, it is only a quiescence, the pathological process is still there and activity, with further necrosis and cavity formation is very apt to follow sooner or later.

During the following year, from February, 1911, to February, 1912, she had occasional symptoms which should have shown that the disease was not healed. Now and then her cough would increase and then quiet down or disappear for a time. In July she had a hemorrhage. In February, 1912, the whole process again became acute. Her cough became very troublesome, temperature developed and the expectoration became more profuse. This was associated with more necrosis and cavity formation. From February until April the patient lost weight, had considerable activity with softening in the lung and passed into the far advanced stage of the disease with a marked destructive process; so, when she entered the sanatorium she was in the far advanced stage of tuberculosis and showed a great deal of cavity formation in the upper part of the right lung, and a great many scattered necrotic foci throughout the remaining portion of the same lung, particularly the upper two-thirds. The disease had also extended to the left lung, where an involvement of moderate severity was present.

As a result of loss of tissue in the right lung, the heart was displaced to the right, the left lung had taken upon itself compensatory emphysematous change to help fill in the space formerly occupied by that portion of the lung which had been destroyed.

Course of Disease During Treatment.—Fig. 159 shows the temperature and pulse records of this patient. It will be noticed that after entrance the patient's temperature was very high for the first three months. The temperature started in the morning near the normal point, but reached a maximum of 101° to 103° in the afternoon. It will be noticed too that the temperature curve ran in waves, there being, on the average, about two high waves each month. This is characteristic of most tuberculous curves. A temperature such as this means a tuberculous pneumonia. It shows that there is sufficient lung tissue involved to produce a constant absorption of toxic substances and a persistent elevation of temperature. When we consider that the normal morning temperature is about 97.5°, we can see that this patient at first had rises of temperature during every portion of the day. The wide swing of the curve which, on some days, amounted to six degrees or more, is characteristic of a markedly destructive process where lung tissue is becoming liquefied and absorbed together with many other toxins of varied nature.

If we undertake to form a picture of the pathological changes that were going on within the lung during the time represented by the fever curve of the first three months it would be something like the following:

Aside from the large cavities which were already formed, there was a still wider area in which the collateral inflammation was very marked and which contained many points of necrosis from which relief could only be had through cavity formation. These foci were markedly inflamed and every now and then some of them softened and were expelled, the process being attended by an increase in the amount of expectoration. Sometimes this was blood-stained, because the destructive process was going on so rapidly that the material was expelled before the vessels could be obliterated. The first occurrence of this kind was on the 21st day of April; again there was a more marked hemorrhage of two ounces on the 27th of May; another one on the 29th; still another on the 1st of June; then on the 4th of June and again on the 8th of June, the sputum being more or less bloody until the 10th of June; then another on the 17th of June.

Following this, the patient felt relieved; there was a decided drop in temperature and pulse. The reason for this was not that these hemorrhages in themselves were beneficial, but that they were associated with the expulsion of caseous masses; and also that the changes in the tissues afforded relief from areas of collateral inflammation from which absorption of toxic materials was taking place. The diurnal variation in the temperature curve at this time became very much less, but this did not last long. Within a week a wide diurnal range appeared, there being more than six degrees variation on certain days. This kept up for about two weeks when on the 13th of July, a rupture of a caseating focus into the right pleura took place, causing a pneumothorax. The adhesions were so dense over most of this right side, however, that the pneumothorax was limited in extent. The heart was only slightly displaced. The patient experienced a sharp pleural pain; followed by dyspnea and a marked decrease in cough and expectoration. She was mentally confused for three or four days, being almost unconscious. The characteristic sharp rise in temperature and pulse occurred as will be seen in the chart. Physical examination showed an area of increased resonance where dullness had previously been found, and breath sounds slightly less distinct than what had been produced by the thickened pleura.

After the patient recovered from this attack of pneumothorax both the temperature and pulse assumed a decidedly lower plane and the diurnal variation in the temperature became less; so that by the middle of September the patient was running a temperature only a little above normal and the heart's action was becoming slower. During this period there was also a marked decrease in expectoration. The sputum dropped from 75 c.c. per day in early September to 25 c.c. per day on the 8th of October. This small amount continued until the death of the patient.

The beneficial effect in this case was not entirely due to the pneumothorax. The pneumothorax was an accident resulting from the rapid softening of lung tissue and was too slight to have any marked compressing effect, although the lessening of the sputum shows that there was some effect. It was followed, however, by the early absorption of air from the pleura, and a very rapid development of compensatory emphysema on the part of the left lung and a shifting of the heart and other mediastinal structures further to the right to take the place of the lost tissue in the right lung. The reason this patient improved so rapidly was because she got rid of an extensive necrotic mass, which at the same time gave relief to the tissues which were the seat of extensive collateral inflammation, from both of which large quantities of toxins were constantly diffusing into the tissues and being absorbed by the circulating fluids. It will be noted by the further course of the disease, as pictured by the temperature curve, that there was a great relief in toxemia. The diurnal variation became less; in fact, during the months of December and January, it approached the normal, running from 98° in the morning to about 99° in the afternoon. During this period, however, it will be seen that every now and then, the expectoration was slightly bloody. For example, during the latter half of September there was color on a number of days. It will also be seen that this was accompanied by quite a steadying of the temperature and pulse curve.

We again see rises of temperature accompanied by chill in the latter part of October, 1912. This irregularity in temperature curve was followed also by traces of blood in the sputum, in the latter part of November, and the first of December. Again, it appeared in the latter part of December and repeatedly in January. The patient then had a slight hemorrhage on the 22nd of March, and a marked one on the 28th, which was again followed by an improved temperature and pulse curve for quite a time. During the latter part of May there was a marked increase in temperature, cough, and expectoration. In both of these instances, on the 27th and 28th of May, and also on the 31st of May and the 1st of June, we must look upon the marked rise of temperature as being due to a greatly increased cough. The probabilities are that if the cough had been allayed the temperature on all of these days would have been several degrees lower. Again, in the early part of July, there was bloody expectoration; also the latter part of August.

During these months, from the middle of September, 1912, to August, 1913, this patient was making good progress. She was slowly cleaning out the areas of involvement and getting rid of necrotic masses and building up new scar tissue. There was not much activity present; yet there was no time when she was entirely free from activity.

The course of the disease in this patient was followed by an unusual amount of bloody expectoration and frank hemorrhages. These seemed to be of three distinct types; first, the frank hemorrhage due to opening of small vessels at the time of acute softening, and cavity formation; second, bloody expectoration from the delicate and probably newly formed capillaries in the walls of chronic cavities; and third, the exudative or congestive type of bloody expectoration, which seems to be of a toxic nature.

In the treatment of these hemorrhages, where they were large, absolute quiet was enjoined. The patient was not even permitted to turn in bed. When hemoptysis was slight on the other hand, the patient was permitted to move, but, under no circumstances, was the patient permitted to leave the bed. The cough was quieted by either heroin or codeine, and, during the larger hemorrhages, $^1/_{12}$ grain of morphine was given sufficiently often to quiet the patient, and to relieve the cough. Veratrum viridi 5 drops every three hours was given until the patient experienced slight nausea, when the dosage was reduced to 3 drops every four or five hours, and continued until the bleeding had ceased. The patient was not allowed to move, following the severe hemorrhages, until the expectoration was free from blood, and was not allowed to sit up until it had been absent for a period of three days. During hemorrhage, the patient was put upon a light diet consisting of milk, eggs, gelatine, and then a more liberal diet was given after a few days. The patient was required to use the bedpan and urinal; and, above all else, the patient was given the comfort that could be derived from an assurance that the danger of death from such hemorrhages was insignificant.

Beginning the middle of August, 1913, there was a decided change in the patient's condition. The patient began to show signs of active disease again. The temperature and pulse showed a wider diurnal variation and the usual periods of high waves about every two weeks.

During this period the patient had a great deal of trouble with the stomach. There was marked dilatation and sagging. Her appetite failed and she suffered from a feeling of fulness after eating, no matter how little was taken. She vomited frequently. Sometimes she complained of discomfort in the abdomen. Expectoration did not increase to any extent, but the whole picture became more serious. The diazo reaction which had not been present from July, 1912, returned. This kept increasing in severity up to the time of her death. The whole picture was that of a more acute disturbance, a greatly lessened resistance on the part of the patient, whose reactive powers, of course, were not nearly as good as they had been earlier.

Though no postmortem was made, it is probable that an intestinal infection was taking place at this time, which, together with gastric dilatation, accounted for her gastrointestinal symptoms. One thing that would indicate this aside from the direct gastrointestinal disturbance is the fact that the pulse rate did not increase during the period of increased toxin absorption during this last activity. It will be seen that from the middle of August, if anything, there was a slight decrease in the rate of the heart's action; the pulse being a little lower than it had previously been, although, at the same time, there was an increase in activity in the disease process somewhere in the body, which was accompanied by a rise of temperature, which persisted until immediately before death. The drop in pulse, together with the diurnal variation in the temperature curve, and her clinical symptoms, point decidedly to an infection of the bowel. The slowing of the heart is reflexly produced through the depressor fibers of the vagus. The patient finally became more or less toxic and died on the 12th day of December.

It will be noticed that a few days prior to death the heart's action began to increase and the temperature lowered. This is characteristic of death in tuberculosis. The heart, being no longer able to do its work, dilates, and the body cells, being no longer able to react, the temperature falls. This separation of temperature and pulse curve can nearly always be seen.

The pulse rate of this patient was extremely interesting during the entire course of the disease. It will be seen that in the beginning of treatment it was running from 90 to 110. This remained high until the relief in toxemia which came with the expulsion of caseous material at the time of the hemorrhage in early June. Following that there was a decided drop which persisted until the activity which preceded the pneumothorax, on the 13th of July. Then the pulse reached 120, but gradually became slower as the temperature dropped. It will be noticed, however, that, by the first of September, the pulse took a higher range, although the temperature curve became lower. This was coincident with the shifting of the heart toward the right. During this period the heart was rapidly shifting to the right and adjusting itself. Working under the strain caused by the new conditions, the pulse was rather slow in adjusting itself, and increased in frequency from 90 to 100.

The treatment which this patient received was the ordinary hygienic dietetic open air treatment, with attention to the different symptoms and complications as they arose.

J. K. was given during the first five months. Beginning the latter part of October tuberculin was used. This was kept up until early in November. J. K. was then used until the 15th of March, when tuberculin was again resumed and continued to the time of the hemorrhage the latter part of May. After that the patient received no more tuberculin, but was treated with J. K. continuously.

Comment.—This case represents a type which is all too common, where the disease is not recognized but permitted to go on without the patient being properly treated until a very actively destructive process results. Even such cases can often be helped very materially and I have no doubt that had it not been for the many complications and the final intestinal involvement, the result would have been very different. This patient showed remarkable tolerance and resistance in the face of overwhelming complications.

The fact that she was able, after a prolonged period of high temperature and rapid destruction of lung tissue, to reach a state of comparative comfort and relief from symptoms and retain the same for nearly a year, shows that we are justified in giving these serious cases the same attention and the same energy that we do any other serious disease. To be sure, one will often fail, but, at times, our efforts will be crowned with success.

Laboratory Examination at Termination of Treatment.—

Sputum:	Date	Dec. 2, 1913.
	Quantity (24 hrs.)	40 c.c.
	Sediment vol.	20 c.c.
	Bacilli per field	100
Urine:	Date	Oct. 25, 1913
	Quantity (24 hrs.)	950 c.c.
	Specific gravity	1016
	Albumin	negative
	Sugar	negative
	Diazo	one-half
	Indican	slightly increased

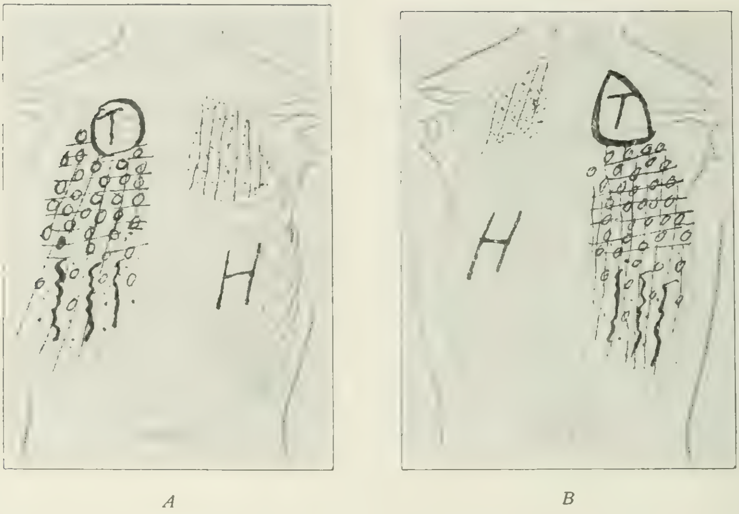


Fig. 158.—Charts of chest, Case 1828.

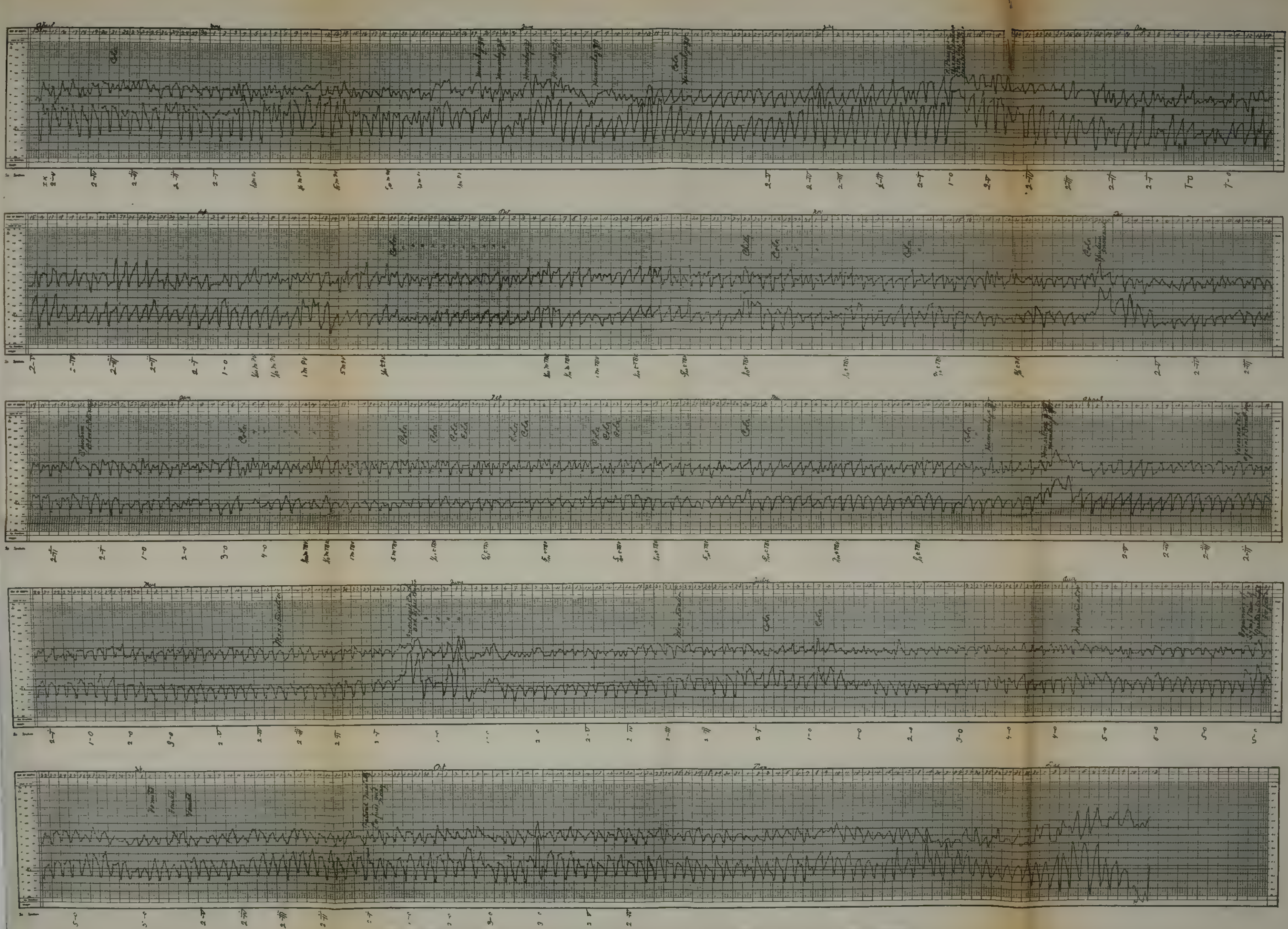


Fig. 159. Charts showing temperature and pulse curves, with clinical notes and doses of tuberculin. Cas. 1828. Upper curve, pulse, lower curve, temperature.

CASE 2637.

ACUTE CASEOUS TUBERCULOSIS WITH EXTENSIVE EXCAVATION IN RIGHT LUNG AND MODERATE INFILTRATION AT LEFT APEX; COMPENSATORY EMPHYSEMA ON LEFT; LARYNGEAL INFILTRATION AND ULCERATION; INTESTINAL INFECTION; SPONTANEOUS PNEUMOTHORAX; DEATH. OBSERVED FROM DECEMBER 12, 1914, TO MARCH 13, 1915.

A Discussion of: The General Symptoms and Course of Acute Caseous Tuberculosis; Cavity Formation; Spontaneous Pneumothorax; Reflex Vagus Stimulation Causing Slow Pulse Probably Indicative of Intestinal Involvement; and Treatment of Tuberculous Laryngitis.

Case 2637.—Student. Age 17. Female. Entered sanatorium December 12, 1914.

Family History.—Father living and well. Mother died at the age of twenty of tuberculosis when patient was one year of age.

Personal History.—Patient suffered from whooping cough and mumps, from which complete recoveries were made. Menstruation regular until recently, when it became more frequent, but scant.

Tuberculous History.—Patient exposed to infection by living with mother until one year of age.

Eight months previous to entering the sanatorium the patient took a severe cold from which she did not recover. Soon after beginning of the cold, hoarseness developed. There was also a tickling in the throat and cough which became very persistent. The cough was accompanied by expectoration which gradually increased, until at the time of entering the sanatorium it amounted to three and a half ounces per day.

Three months prior to entrance she noticed that she was tiring easily anl her endurance was failing. Her appetite was capricious, and, at the time of entrance she had absolute disgust for food, and, at times, suffered from nausea and vomiting. She lost weight to 110 pounds, 115 pounds being her normal weight.

Two months prior to consulting me she had a hemorrhage of about half an ounce; and, at frequent intervals after that time, raised small quantities of blood amounting to from ½ to 1 dram. Her temperature had ranged from 101° to 103°. Tubercle bacilli had been found in the sputum one month previously. She complained of pain in the scapular region. She also had some pain in the throat on swallowing, particularly spicy or acid foods. The voice was extremely hoarse. She was greatly depressed and spent much of her time crying.

The symptoms in this case could be tabulated according to their etiology, as follows:

SYMPTOMS DUE TO		
Toxemia	Reflex Stimulation	Tuberculous Process *per se*
Malaise	Hoarseness	Hemorrhage
Lack of endurance	Cough	Sputum—with bacilli
Marked depression of spirits.	Nausea	Tuberculous bronchitis
	Vomiting	
Disturbed appetite		
Loss of weight		
Rapid pulse		
Temperature		

The symptoms on the part of the larynx were hoarseness and pain on swallowing.

Examination.—General appearance pale. Temperature 102.8° at 4:00 P. M. Pulse 120. Blood pressure, right arm, 88; left arm, 94. Dyspnea slight. Sleep disturbed on account of cough. Bowels, constipated.

	RIGHT		LEFT	
	Degeneration	Spasm	Degeneration	Spasm
Sternocleidomastoideus	— —	+	—	+ +
Pectoralis	— —	+	—	+ +
Trapezius	— —	+	—	+
Levator anguli scapulæ	Slight to fourth rib anteriorly — Marked to angle of scapula posteriorly — —	+	—	+
Rhomboidei		+	—	+
Degenerated subcutaneous tissue			Slight to second rib and angle of scapula	
Lessened motion	Marked		Moderate	

Condition of the Muscles and Subcutaneous Tissue.—The condition of the muscles and subcutaneous tissue is shown in the preceding table in which the — sign is used to indicate degeneration, and the + to indicate spasm. The degree of spasm and degeneration is indicated by the number of signs one meaning slight; two marked, and three very marked.

Deep Palpation.—RIGHT.—*Anteriorly.*—Increased density of the tissues to the fourth rib except over the area of decreased resistance over the first interspace, which gave the impression of loss of tissue. *Posteriorly.*—Increased density of the tissues to the lower third of the scapula, except near the apex where decreased density suggestive of cavity, was noted. Also increased density at the right base, suggestive of pleural inflammation. LEFT.—*Anteriorly.*—Density of lesser degree to the third rib. *Posteriorly.*—Same to upper third of the scapula, also decreased density and increased tension in the lower part of the left lung, indicative of emphysema.

Suggested Diagnosis from Inspection and Palpation.—From the degeneration of the muscles and subcutaneous tissue over the upper portion of the right lung, we infer that this has been the seat of an old lesion. From the fact that the muscles are in spasm at the present time, we infer that there is activity going on. The increased density throughout the upper portion of the lung, except the decreased resistance near the apex indicates a widespread infiltration with cavity in the upper portion. The condition of the tissues near the base indicates an old pleural inflammation. The condition of the muscles and soft tissues on the left side, indicates that this lung has been diseased over a long period of time. The marked spasm of the muscles, however, indicates a markedly active infection at the time of examination. The increased resistance on deep palpation over the upper portion of the left lung further indicates an infiltration at this apex; while increased tension with decreased density over its lower portion indicates the presence of compensatory emphysema.

Percussion.—Percussion confirms the palpatory findings. RIGHT.—*Anteriorly.*—Moderate dullness to the fourth rib. *Posteriorly.*—Moderate dullness to the lower third of the scapula, with tympany over the area of decreased resistance noted on palpation over the first intercostal space, and the upper portion of the interscapular space. Also slight dullness at the base. Left.—*Anteriorly.*—Moderate dullness to the third rib.—*Posteriorly.*—Moderate dullness to the upper third of the scapula, with hyperresonance in the lower portion indicative of emphysema.

Auscultation.—Right.—*Anteriorly.*—Upper portion extending to the fourth rib, the seat of rough, harsh inspiration with prolonged expiration, somewhat blowing in character in the first interspace, and accompanied by many medium râles. *Posteriorly.*—The same condition was found extending to the lower border of the scapula, and decidedly blowing expiration with whispering voice over the apex and the upper portion of the interscapular space. A decided amphoric note was heard over the middle of the first interspace. Left.—*Anteriorly.*—The breathing in the upper portion of the left lung showed a rough harsh inspiration with harsh prolonged expiration and numerous fine râles to the third rib. *Posteriorly.*—A few medium râles extending to the upper third of the scapula. The lower portion of both lungs was emphysematous to the base, that on the left being more marked.

Examination of the Abdomen.—The examination of the abdomen showed the stomach within its normal limits, the lower pole of the right kidney one inch below the navel, and an increased tension of the muscles on the right side, which made me think of the possibility of an intestinal involvement.

Laboratory Findings.—

Sputum:	Date	Dec. 14, 1914
	Quantity (24 hrs.)	105 c.c. mucopurulent
	Sediment vol.	10 c.c.
	Bacilli per field	20
Urine:	Date	Dec. 14, 1914
	Quantity (24 hrs.)	1000 c.c.
	Albumin	negative
	Sugar	negative
	Diazo	1
	Indican	normal
	Specific gravity	1016
Blood:	Date	Dec. 14, 1914
	Hemoglobin	90%
	Leucocytes	12,950
	Lymphocytes	13.8%
	Arneth index	87

Diagnosis.—Extensive infiltration throughout the right lung. Upper lobe caseous with large cavity near apex. Pleural thickening at the base. Moderate infiltration in upper left. Lower left markedly emphysematous. Tuberculosis of arytenoids with ulceration on right side. Infiltration of cords. Probable infection of intestines. The condition of the lungs is shown in Fig. 160, page 630, at end of description.

Prognosis.—Unfavorable. Patients of this class are particularly unfavorable.

Analysis of the Case.—*Course of the Disease Prior to Observation.*—The analysis of the case up to and including the condition at the time of entering the sanatorium would be somewhat as follows:

There was ample opportunity for this patient to become infected through her mother; and we assume this is the probable source. The patient developed normally and showed no symptoms until sixteen years of age. From the character of the symptoms shown eight months prior to entering the sanatorium, we know that the disease had already extended to the lung, for the symptoms were not those accompanying an early infection, but those of a moderately active disease. The patient had a "severe cold," which meant in this case, a bronchitis of tuberculous origin due to renewed activity in an old focus of infection in the right apex. She had a tickling in the throat, hoarseness and cough accompanied by expectoration. There was also probably some malaise, digestive disturbance, and rise of temperature at this time, although the patient does not give it in her history.

Clinical history alone at that time should have made a diagnosis, and, if accompanied by a physical examination, should have left no doubt. A tuberculin test would undoubtedly have given a prompt maximum reaction, and the examination of the sputum, at least a twenty-four hour sample, after fermenting, would doubtless have shown bacilli present.

After this first period of activity there was a cessation in the severity of the symptoms, although the "cold" did not disappear wholly, and the cough persisted.

Three months before she consulted me there was an exacerbation of the disease. All symptoms became more marked than they had been at the beginning. The temperature rose to 101°

and 102°, the pulse became frequent, the appetite capricious, and she lost weight. Hoarseness increased. In a very short time the expectoration was accompanied by blood. The expectoration increased greatly and was frequently blood-tinged. The pathology of this period was that of necrosis, caseation and cavity formation. If necrosis occurs and a cavity forms quickly, the rupture is very apt to be accompanied by some bleeding; usually small amounts are brought up, mixed more or less intimately with the sputum. The cause of the bleeding is that destruction of tissue has taken place before the accompanying inflammation has had time to seal off the small vessels.

During this time of marked activity in the pulmonary focus it is probable that metastases took place in the larynx and intestinal tract. The symptoms above mentioned persisted. The symptoms on the part of the larynx also became more marked. The fact that there was pain on swallowing, particularly on swallowing spicy and acid foods, shows that ulceration of the larynx was most probably present. When the patient entered the sanatorium, she was suffering from a severe infection of the lungs, and the larynx, also probably an involvement of the intestinal tract, as revealed by physical examination.

The condition of the larynx showed a disturbance of adduction in the right cord, which accounted in part for her extreme hoarseness. There was infiltration of both arytenoids and interarytenoid spaces, and cords with an abrasion on the right arytenoid.

We found a severe destructive process going on in the lungs; that in the right lung being older than that in the left, much more extensive, and also much more severe. We had evidence of cavity in the upper part of the right lung, both anteriorly and posteriorly. The infection was more recent in the left lung and not so active.

Treatment.—The chances for an arrestment in this case were decidedly unfavorable under any circumstances. Under proper treatment, however, there was a possibility of improvement. This patient entered the sanatorium and was placed under a hygienic dietetic regime. She was kept in bed at perfect rest, not allowed to sit up during any portion of the day at first. She was allowed visitors only for a short period each day, most of the time being spent alone except as seen by physicians and nurses.

She was put upon tuberculin. This is interesting because of the usual belief that tuberculin is of no value and harmful in temperature cases. I must say that I would not advise the use of tuberculin in such cases except by those who have had considerable experience in its use. By the course of the disease as observed from the temperature charts we may be sure that no harm was done by it.

Course of the Disease During Observation.—The temperature and pulse curves are shown in Fig. 161. If we undertake to discuss the course of the disease during the first month of observation, we will note that on entrance both the temperature and pulse curves were high; and that, after the patient was at rest, there was a marked drop. This was followed by a slight daily drop in the temperature curve, lasting for a few days, when it again assumed a higher level, which lasted some two weeks. This was again followed by a gradual reduction in the daily maximum and a lessening of the frequency of the pulse. The physical examination at the end of the first month showed a general reduction in the severity of the physical signs over the area of involvement. (See chart, page 630.)

By observing the temperature chart and accompanying symptoms, and comparing the changes found in the chest on physical examination, we are able to trace the pathological changes which had been going on within the lung fairly accurately.

The numerous medium and large râles which were heard in the upper portion of the right lung in the region of the cavity, also those in the posterior portion of the left lung, were indicative of a disease of marked severity. Not only do we have evidence here of tuberculous foci, but we also have evidence of a widespread collateral involvement due to diffusion of the toxins and bacillary products from the foci of infection out into the adjacent tissues.

The altered breath sounds in the anterior portion of the left lung showed a metastasis less widely spread and also a collateral involvement of less severity.

The danger in this case at the time of entrance and to a less degree at the end of the first month was that the necrosis would become widespread, that those portions of lung adjacent to the cavity would go on to a process of caseation, and also that caseation might occur in the left lung, particularly posteriorly.

This extensive active process could not be looked upon other than as a pneumonic condition, a tuberculous pneumonia. This would be suggested by the character of the temperature curve. This patient had temperature every hour of the day. Her morning temperature was 98° to 99°, instead of 97° or 97.4°, her afternoon temperature ranged from 101° to 102°. There was a diurnal variation of about three degrees, showing, as I interpret it, that considerable autolysis was going on, and that the lung tissue was breaking down and that many toxins of various character were being absorbed. The vasomotor control was badly disturbed.

After the patient had been under observation for about three weeks, it will be noticed that she again began to expectorate bloody sputum. There was no distinct hemorrhage but the sputum was decidedly blood-tinged. Following this there was a gradual decline in temperature and pulse, a marked alleviation of all symptoms, including a return of appetite. The reason for this change was that some focus of infection had undergone necrosis and caseation and was actively inflamed, throwing off toxins which were producing marked clinical symptoms. The focus had broken down, ulceration had occurred, and the patient was relieved from absorption. This was accompanied by a marked amelioration of all symptoms. The patient's appetite improved; she became much brighter; she slept better; her cough decreased and her mental depression was greatly relieved.

The laboratory report made at this time, on the 8th of January, showed 75 c.c. of sputum, which was a reduction of 30 c.c., and an increased number of tubercle bacilli, 30 to the field, which is characteristic of caseation and breaking down of a tuberculous focus.

This general improvement continued until the end of February. The temperature remained low and the pulse was even below what it should have been with the condition of the patient, a fact which will be explained later. On the second of February it will be seen that there was a sudden rise in temperature, the maximum on the second being 99°, and on the third, 102.4°. This was also accompanied by a corresponding rise in pulse. It will be noticed that both temperature and pulse continued on this high level until a few days before death, when they separated; the pulse becoming more rapid and the temperature gradually decreasing.

This sudden rise in temperature was due to a spontaneous pneumothorax. Such a rise as this in the course of tuberculosis is nearly always due to this complication, and where accurate records of the pulse and temperature have been preserved, the diagnosis of pneumothorax may be made with probably 90 per cent accuracy upon this sudden rise of temperature and pulse alone. This rise was accompanied by the following symptoms:—a pain in the left side, mental confusion, an increased amount of cough and expectoration with some free hemorrhage. The pneumothorax occurred, unfortunately, on her left side, the side less extensively involved; but was prevented from being complete because of the widespread and dense adhesions over the upper portion. The heart was pushed toward the side of greatest involvement. The increased amount of sputum was due partly to the forcing of the sputum from the necrotic areas in the left lung, and partly to the fact that it threw much more work upon the right and badly diseased lung.

After this attack of pneumothorax, the patient began to fail. The toxemia was severe, her appetite failed, and she became extremely nervous and depressed and continued so until the time of her death, which occurred March 13, 1915.

One thing of great interest in this case is the pulse. It will be seen from the beginning that the pulse was relatively low as compared with the height of the temperature. This I have described elsewhere (page 42) as being characteristic of increased vagus stimulation, and usually pointing to an involvement on the part of the bowel. In this case, however, there were three sources from which reflex vagus stimulation, tending to slow the pulse, might come, the intestines, the lungs, and the larynx. It will be noted that the temperature dropped during the last half of January, and that the pulse came down even to 75, although the temperature was reaching a maximum between 99° and 100 each day; and, during the last month, after the pneumothorax had occurred, the pulse still held to about 100 beats per minute, while the temperature was reaching a maximum of 103° and 104°. The separation of the pulse and temperature during the patient's last week of life is characteristic of the death which occurs when the heart dilates.

When a pneumothorax occurs the patient requires special attention. Our efforts must be directed toward keeping the amount of air which escapes into the pleura as small as possible; further, the heart needs to be supported because of the extra strain which is thrown upon it. These indications are met by keeping the patient at rest, not permitting any exertion and reducing the cough to the lowest amount possible. To this end morphine is probably the best remedy, as it supports the heart, while it also reduces cough. We use this in doses of 1-16 gr. hypodermically at frequent intervals. If this is not sufficient, we use larger amounts up to ¼ grain, repeating it as indicated. As a rule, the acuteness of the symptoms passes over within a few days. In this case, however, there was no improvement. The pleura became infected and the patient gradually succumbed to the toxemia.

The larynx was treated by mild measures. Cold compresses were applied to the larynx each night. The patient was requested not to irritate the larynx by talking. Medicinally we relied upon keeping the larynx clean by the use of alkaline spray and by daily applications of 10 per cent argyrol and 20 per cent protargol.

Laboratory Examination at Termination of Treatment.—

Sputum:	Date	Feb. 11, 1915
	Quantity (24 hrs.)	110 c.c.
	Sediment vol.	20 c.c.
	Bacilli per field	100 c.c.
Urine:	Date	Feb. 11, 1915
	Quantity (24 hrs.)	700 c.c.
	Specific gravity	1018
	Serum albumin	large trace
	Serum globulin	negative
	Sugar	negative
	Diazo	⅕
	Indican	slightly increased

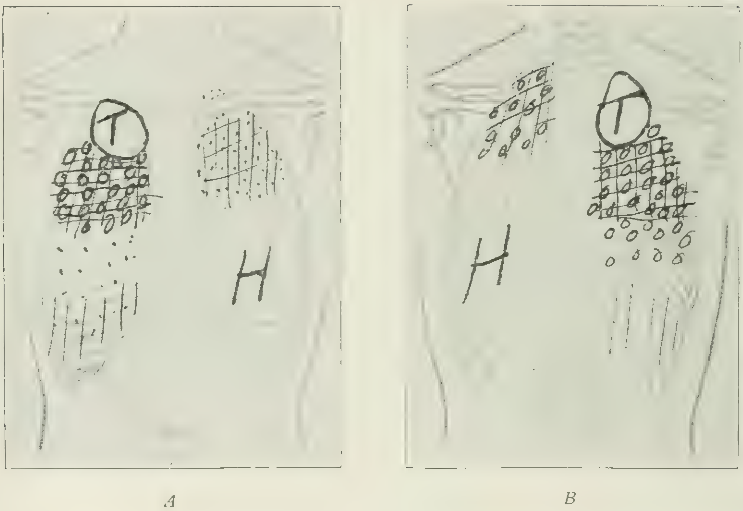


Fig. 160.—Charts of chest, Case 2637.

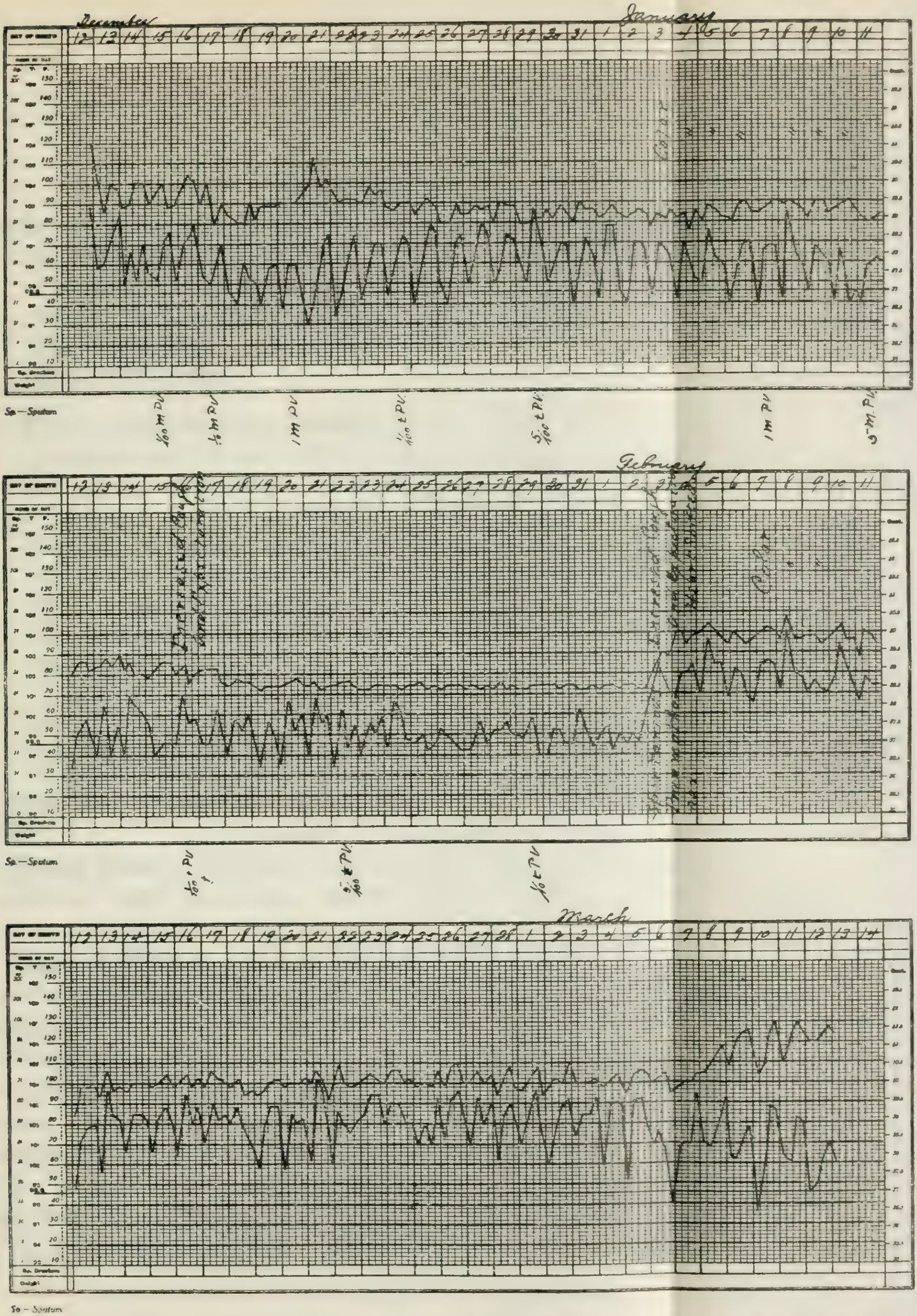


Fig. 161.—Charts showing temperature and pulse curves, with clinical notes and doses of tuberculin, Case 2637. Upper curve, pulse; lower curve, temperature.

CASE 2383.

CHRONIC FIBRO-ULCERATIVE TUBERCULOSIS: DELAYED DIAGNOSIS AND WRONG EARLY ADVICE: COMPLICATING TUBERCULOUS ENTERITIS WITH OPERATION: TEMPORARY ARRESTMENT: LATER, DISEASE PROGRESSIVE. OBSERVED FROM JULY 5, 1913, TO AUGUST 9, 1916.

In Which is Discussed the Importance of Definite Instructions and Definite Control of Early Cases; the General Course of a Case of Moderate Activity; Menstrual Rise of Temperature; Effect of Worry; the Relationship of the Pathology to the Clinical Symptoms; Abdominal and Pelvic Symptoms, Leading to Operation, With the Surprising Disclosure of a Widespread Tuberculous Inflammation of the Intestine, Which Had Not Manifested Any Suspicious Symptoms; After Course With Activity in Both Pulmonary and Intestinal Lesions; the Slow Pulse in Intestinal Tuberculosis, Due to Reflex Depressor Effect Through the Vagus; and Dilatation of the Stomach.

Case 2383.—Housewife. Age 24. Entered sanatorium on July 5, 1913.

Family History.—Father living and well. Mother died of tuberculosis in 1909. One sister recently suffered from tuberculosis, but is now better.

Personal History.—Strong and well as a child. Had usual children's diseases. Had typhoid fever when 10 years of age followed by relapse, but recovery seemed to be satisfactory.

Tuberculous History.—During the year 1908 the patient was not strong. She noticed that her endurance was not as good as usual. In 1909 she became pregnant and during pregnancy seemed better; and remained so until the child was about one year of age. She nursed the child until it was sixteen months old, but during the last six months of that time felt that she was gradually losing out. When she weaned the child her health was very much below par and she has never been able to recover her former strength. She has continuously felt tired and nervous, and, in the Spring of 1912, began coughing.

In May, 1912, she came to California for her health. A diagnosis of incipient tuberculosis was made at that time, but she was given only general instructions and told to take good care of herself. Not realizing what that meant she spent most of the time at the beach going out in the evenings and doing considerable swimming each day. In spite of this she gained in weight and seemed some better. After three months' time she felt that if she was able to do these things she must be well, consequently returned East to her home, and took up her usual duties, both household and social.

In February, 1913, she attended a dance and tired herself out. She became chilled and was taken down the following day with pleurisy. This was followed at once with fever, cough and expectoration; and bacilli appeared in the sputum. She developed hoarseness and at times had almost complete aphonia. She had considerable cough, particularly in the morning, and raised quite an amount of sputum. Temperature developed, which reached 101° and 102° and a few days before consulting me she had a slight hemorrhage.

In July, 1913, she came to California again and consulted me on the 5th of the month.

The symptoms in this case could be tabulated according to their etiology as follows:

SYMPTOMS DUE TO		
Toxemia	Reflex Stimulation	Tuberculous Process *per se*
Malaise	Hoarseness	Pleurisy
Nervous irritability	Tickling in larynx	Tuberculous bronchitis
Loss of strength	Cough	Hemorrhage
Disturbed appetite		Sputum, bacillus-bearing
Loss of weight		
Increased pulse rate		
Temperature		

Examination.—Patient showed that she had lost much weight, weighing 106, her normal being 125 pounds. She was pale and anemic. Had temperature of about 100°, which was followed very shortly by a higher wave, at which time it reached 102°. Pulse was running from 80 to 90. Patient was sleeping well. Suffered from constipation.

Condition of the Muscles and Subcutaneous Tissue.—The condition of the muscles and subcutaneous tissue is shown in the following table in which the — sign is used to indicate degeneration, and the + sign to indicate spasm. The degree of spasm and degeneration is indicated by the number of signs; one meaning slight; two marked, and three very marked:

	RIGHT		LEFT	
	Degeneration	Spasm	Degeneration	Spasm
Sternocleidomastoideus	— —	+		+ +
Pectoralis	— —	+		+ +
Trapezius	— —	+		+ +
Levator anguli scapulæ	—	+		+ +
Rhomboidei	—	+		+ +
Degenerated subcutaneous tissue	To third rib anteriorly and lower third of scapula posteriorly			
Lessened motion	Marked		Marked	

Deep Palpation.—Right.—*Anteriorly.*—Markedly increased resistance from the apex to the fourth rib. *Posteriorly.*—The deep resistance was very much increased from the apex to the lower angle of the scapula. Left.—*Anteriorly.*—Slightly increased resistance over the left lung from the apex to the fourth rib. *Posteriorly.*—Slightly increased resistance from the apex to the upper third of the scapula. The right and left borders of the heart in normal position.

Suggested Diagnosis from Inspection and Palpation.—Owing to the fact that the total resistance over that portion of the right lung from the apex to the fourth rib anteriorly and from the apex to the angle of the scapula posteriorly was increased, I inferred that there was an infiltration occupying those portions of the underlying lung. From the fact that the subcutaneous tissue and muscles over the upper portion were degenerated, I inferred that this lesion was an old one and that it had existed in the lung for a considerable time. From the fact that besides the degeneration these muscles also showed slightly increased tone, I inferred that there was some activity in this old process at this time. From the fact that the deep resistance in the left lung was slightly increased to the third rib anteriorly and to the upper third of the scapula posteriorly, I inferred that there was infiltration of the underlying lung tissue. From the fact that the muscles overlying this area showed increased tone (spasm) and there was no degeneration either of the muscles or subcutaneous tissue present, I inferred that the lesion in this lung was a recent one and active.

Percussion.—RIGHT.—*Anteriorly.*—Marked dullness to the fourth rib. *Posteriorly.*—Marked dullness from the apex to the lower angle of the scapula. LEFT.—*Anteriorly.*—Moderate dullness to the third rib. *Posteriorly.*—Moderate dullness from the apex to the spine of the scapula. Percussion also confirmed the findings on deep palpation, both as to the infiltration in the lung and the outlines of the heart.

Auscultation.—RIGHT.—*Anteriorly.*—Rough harsh inspiration with harsh prolonged expiration with numerous medium râles above the third rib. Rough harsh inspiration with prolonged expiration without râles over third interspace, and exaggerated breathing to the base. *Posteriorly.*—Rough harsh inspiration with harsh prolonged expiration and numerous medium râles from the apex to the middle of the scapula. Slightly rough harsh inspiration with prolonged expiration and mixed râles brought out on coughing to the lower angle of the scapula. LEFT.—*Anteriorly.*—Slightly rough harsh inspiration with prolonged expiration and sensation of stickiness to the third rib. *Posteriorly.*—Slightly rough harsh inspiration and prolonged expiration and sensation of stickiness extending from the apex to the lower third of the scapula.

Auscultation reveals an old process in the upper lobe of the right lung and a newer process in the lower lobe of the right lung. The harsh character of the respiration in this instance indicates to my mind that considerable fibrosis has taken place. The number of medium râles present indicates that at the present time there is considerable collateral inflammation present; and, inasmuch as these are localized more markedly at certain points, I take them to be indicative of necrosis and caseation. The process in the left lung is a newer process and represents recent infiltration which is accompanied by collateral inflammation of very slight degree which, so far, has not gone on to the point of ulceration and destruction of tissue.

Examination of other organs revealed no tuberculous complications.

Laboratory Findings.—

Sputum:	Date	July 9, 1913
	Quantity (24 hrs.)	65 c.c.
	Sediment vol.	7 c.c.
	Bacilli per field	100
Urine:	Quantity	900
	Albumin	negative
	Sugar	negative
	Diazo	negative
	Indican	normal
	Specific gravity	1022
Blood:	Hemoglobin	80
	Leucocytes	11,500

Diagnosis.—An old fibroid tuberculosis in upper lobe and apex of lower on right side which is now the seat of renewed activity. Moderately extensive necrosis and some cavity formation. A new process on the left involving upper half of upper lobe and apex of lower. The condition in the lungs is shown in Fig. 162.

Prognosis.—The prognosis in this case is questionable. Without proper treatment it would most probably be progressive to a fatal termination, although, under proper treatment, should have an opportunity for improvement.

Analysis of the Case.—The history of this patient prior to entry shows a gradual decline in health over a period of four or five years. Prior to pregnancy there was a definite loss of strength and endurance which, in the light of the after history, was in all probability due to her infection. The fact, however, that she ran down during the period that she was nursing the child, and was never able to regain, and suffered from lack of endurance and increased nervousness until her definite symptoms appeared, makes it appear that she was suffering periodically from symptoms of active tuberculosis from the time mentioned until a clinical diagnosis was made. When the diagnosis was made in 1912 and the patient came to California, she improved at once. Had the patient during the time of this improvement, been properly controlled and followed up, there is little doubt that a complete recovery could have been made. This case, like so many others, illustrates the importance of definite instructions, and definite control of these patients who are fighting early tuberculosis. There is no time when the disease yields as readily but also no time when the patient requires more careful watching and guidance.

The course followed by this patient was a very unfortunate one; and, mistaking her rapid gain of strength (which would come to almost anyone in her condition by simply a change of climate) for a cure, she immediately, injudiciously overrated her strength and soon lost all that she had gained, and suffered from renewed activity, which is always more difficult to control than an early lesion.

On entering the sanatorium, she had been suffering from an active lesion for five months. During this period she had been running temperature, had been coughing, and had quite free expectoration. At the time of entry she was suffering from an extensive tuberculosis, both lungs being involved. The entire upper lobe on the right and most of the lower lobe was the seat of active inflammation; and the upper lobe, particularly, was the seat of a destructive process, although no marked cavities could be detected. The extension to the left lung was more recent and had not gone on to breaking down, but made the case more serious because it increased the extent of the disease.

Course of Disease During Treatment.—The course of the disease may be inferred from Fig. 163. After entering the sanatorium, the patient was put to bed, where she remained for the most part during her first stay in the institution, which terminated on the 7th of October. (See chart at end of description.)

It will be noted that her temperature curve started in the morning on first awakening, at 98° and a little above. Her afternoon temperature reached 99° and 100° and about the middle of the first month went as high as 101° and 102°. This high wave of temperature was accompanied by increased cough and increased expectoration which was slightly blood-tinged. This was followed by a remission in temperature which lasted for two months, the patient then having a relief from symptoms and experiencing a general improvement. During this time her weight increased from 106 to 111 pounds. If we analyze this early temperature we must classify it as being of the pneumonic type. It is caused by a continuous inoculation of toxins. The temperature of this patient started higher than it should in the morning; whereas the normal temperature should be between 97° and 98°, probably about 97.4°, this patient's temperature started at 98° and above, and each day went up to nearly the 100° mark. There was no time of day that this temperature was not above normal for that time of day. The marked increase in temperature beginning about the 20th of July was unquestionably associated with increased inflammation. Such rises as this come, as a rule, when caseation and cavity formation are taking place. Multiplication of bacilli and diffusion of toxins into the neighboring tissues take place. This is accompanied by an increased inflammation and exudation and an accentuation of clinical symptoms, such as cough, expectoration, sweats, loss of appetite, elevation of temperature and increased nervousness. The accompanying symptoms were increased at this time and the expectoration was slightly bloody, due to the rupture of capillaries at the time of the cavity formation.

During the second month the patient's temperature was very regular, although not a normal temperature. It indicated that there was inflammation still present. It was a little higher than it should be most of the time, although the diurnal variation was not great. During the third month the diurnal variation remained practically normal, but on the 27th of September the temperature assumed a higher maximum, also a slight increase in the diurnal variation. These variations in temperature were quite usual in this patient at the time of menstruation. The temperature would go higher than usual a little before or after the period time and usually remain so for several days. This is illustrated at the period time which began on the 26th of September. Her temperature started on the 27th and continued for several days. This led me to think that possibly there might be some disturbance in the genital tract. Later, when the patient came to operation it was found that there were adhesions between the tubes, ovaries, and intestines, and also that the patient had tuberculous enteritis and a sharply retroflexed uterus. At the end of her third month she weighed about 110 pounds. The patient left the sanatorium on October 6, 1913.

During the months of October and November the patient had many things to worry her. She had left the sanatorium and was more or less disturbed by household worries, although she was not attempting to do work herself. The influence of this is shown in the temperature curve. The curve assumed a higher general elevation. The morning temperature beginning at or near normal, and the afternoon reaching a maximum of 99° or 100°.

The accumulative effect of these extra cares began to show itself about the first of November, when the diurnal variations became greater and came to a climax during the latter part of November during and immediately following a menstrual period by attaining a diurnal variation of nearly five degrees with a greatly increased cough and free expectoration.

At this time she decided to return to the sanatorium and reentered on the second day of December. The effect of favorable surroundings was shown at once by the decrease in her temperature; but it will be noted that in the latter part of December, a few days after menstruation, she had another rise, although not so great as the one of November. This was again followed by a remission during the first few days of January followed later by a marked rise with increased cough and expectoration immediately preceding the menstruation. Following menstruation this time, there was a drop in temperature, instead of the usual rise; but this was followed a few days later by a very marked rise which came on three days following a dose of tuberculin. Whether or not there was any relationship between this dose of tuberculin and the rise of temperature is open to question. The fact that the morning temperature on the first day and second day following the dose was the same as it had been on the preceding days, in fact a little lower, would, according to my experience with the remedy used, indicate that this was not a tuberculin reaction, although it is possible that it might have been. On the other hand, it is possible that a necrotic focus, which was ready to rupture might have been hastened in its action, because accompanying the rise which started on the 21st of January, there was a very marked increase in cough, and free expectoration such as would occur when a tuberculous mass is expelled.

It is interesting to note that during the months of December and January, while the temperature curve was not particularly satisfactory, the patient was not only holding her own, but gaining a little in weight; and that she increased two pounds from the first of December to the first of February.

In January a rise of temperature was noted preceding menstruation and while this dropped a few days following menstruation, it did not drop to normal, and was followed by a very abrupt rise, beginning on the 21st of the month. The rise preceding this menstrual period was higher than that which normally occurs because of the increased sympathetic stimulation produced by the ovarian secretion. It will be noted that the curve in the evening was markedly higher than that for the remaining portion of the day, the rise being more or less abrupt. Such abrupt rises will be seen to be much more marked in the last few charts. Rises of this kind which are so far above the body of the temperature are usually due to some condition other than the tuberculous toxemia. This was the cause in this case. The maximum body of the temperature of this patient was a little over 99°, but the maximum temperature recorded in the evening was over 100°. It will also be noted that this rise of temperature was followed a few days later, after menstruation, by a very marked rise, accompanied by other symptoms of toxemia. The patient coughed very severely and after a few days obtained relief through free expectoration. In treating tuberculosis in patients it is very common to have an exaggeration of all symptoms immediately prior to the period time. If activity is present in the lung it is not uncommon to have it culminate at the time of menstruation; so, increased cough and expectoration are very common at this time, and improve as the period passes over.

During the early days of March, the diurnal variation was not very great, but on the 13th of March it began to increase. This was followed on the 14th by the beginning of extra cough which continued for a period of two weeks. On the 20th of March her temperature reached nearly 104°. This was preceded by a chill, pleurisy, cough and quite free expectoration. During the three months following there was a general improvement in temperature. The next month following the rise of temperature just mentioned was marked by a greater diurnal variation than normal; also a continued rise considerably above normal; but, beginning the latter part of April, the temperature began to drop and assumed the normal diurnal variation, the morning being 98°, the maximum for the afternoon being 99°.

The entire temperature curve from the beginning illustrates a rather common type of this disease. It is a combination of the ulcerative and fibroid type in which the ulcerative type predominated for the time. When this patient entered the institution there was rather a widespread disease. There were many foci of infection and much exudative inflammation throughout the tissue, particularly in the right lung, and we can see in the rises of temperature that occurred every now and then, accompanied by increased cough and more free expectoration, that breaking down of tissue was occurring; and it will be noticed also that after these acute processes passed over there was a general relief for a number of days.

After the last marked rise which occurred in March, a relief was experienced which had not come to the patient prior to this time. The symptoms during this rise were the most severe that the patient had suffered. She had a severe chill, the temperature went high, she suffered from pleurisy and the general symptoms of toxemia, and was extremely ill for a number of days. What occurred at this time, however, seemed to give her relief for quite a time; and after the general inflammation which was associated with the rupture of this mass disappeared, the patient had relief from toxemia and was free from symptoms until the time she left the sanatorium,—July 7th. During this time she regained the weight of 114 pounds, which she had reached previously. She was in splendid general condition, although not ready to be discharged. She was forced to go, however, because of circumstances beyond her control.

In order to successfully treat tuberculosis the physician must carry in his mind an idea of the pathological changes that are taking place in the lung, otherwise he can form no idea as to whether the patient is progressing or not. If we are going to be guided only by the fact that there is a rise in temperature, there was no time that we would have felt satisfied with this patient's condition until May and June of 1914, because every now and then rises of temperature occurred. If, however, we bear in mind the pathological changes that are taking place, we know that this patient was improving all the time. The temperature alone would have given the idea in January, February, March, and even April, that the patient was in a critical condition, and yet, taking into consideration that the patient's general condition was good, that she was not particularly losing weight, that she had not suffered severely from toxemia, we are forced to conclude that she was progressing satisfactorily. There is no remedy or measure to be utilized that can prevent these patients from having fever after they reach the stage where they have considerable inflammation in tuberculous foci and a marked exudative process in the adjacent tissues. It is necessary to go through this toxic stage and there is nothing that can relieve it except relief from the active inflammation. This relief may come when the tuberculous processes rupture and cavities form; or it may and does sometimes come by gradual transformation of the inflammatory areas into fibrous tissue; but, whichever process occurs a certain amount of elevation of temperature will be present until the patient arrives at such a condition that he can rapidly and satisfactorily take care of all the toxins that are produced, without having a noticeable disturbance in vasomotor equilibrium resulting in an elevation of the temperature curve.

When called in consultation I often have the question asked me, "What can be done to bring down a temperature such as this? I am using this remedy, or that remedy, and yet the temperature does not reduce." If we recall our pathology we know that it cannot be reduced by any remedy. The process must go through the necessary pathological changes before relief can come. Now the question arises, Can such a patient as this be successfully treated with tuberculin? I am of the opinion that he can, although I do not consider such a case an easy one for tuberculin treatment. The dosage must be carefully measured and the intervals properly spaced, and the whole picture of the patient must be taken into consideration. I would not advise such a case to be treated with tuberculin by one without a fairly large experience.

The first thing that was noticed, when this patient was put upon treatment, was a general relief from toxemia. This might have occurred even had she not received tuberculin; but, in my experience, this remedy has proved to be a great aid in helping in such cases as this.

The mistake which the friends of this patient made was in concluding that the improvement made during the first three months, guaranteed that institutional treatment was no longer necessary. Against the patient's will she was forced to leave the institution, the result of which is very plainly seen in the two months at home and in the months following at the sanatorium. While substantiating evidence cannot be produced, yet I have no doubt in my own mind that had this patient continued in the institution, the activity which appeared during November and the following months would have been avoided, and an arrestment would have been attained.

The elevation of temperature which began on the 21st of January and the 20th of March, respectively, deserves some discussion. Their relationship to the preceding doses of tuberculin may not be exactly clear. We must realize that doses of tuberculin such as these, if they produce a focal reaction, might hasten the rupture of a tuberculous mass; but, if it does, no harm occurs, because such a rupture must come before relief can be had; and while these two elevations stand in exactly the same relationship to the doses which preceded them and appear to be definite reactions I would hesitate to interpret them definitely as such, although I believe that the process of softening and cavity formation which succeeded them was probably hastened by them. In fact, I look upon this as one of the favorable actions of tuberculin, but one which must be carefully controlled that harm may not result.

Laboratory Examination at Termination of Treatment.—

Sputum:	Date	June 26, 1914
	Quantity (3 days)	5 c.c.
	Sediment	1 c.c.
	Bacilli per field	5
Urine:	Date	June 24, 1914
	Quantity (24 hrs.)	1050 c.c.
	Serum albumin	negative
	Sugar	negative
	Diazo	negative
	Indican	normal
	Specific gravity	1024

Blood:	Date	May 19, 1914
	Hb.	85
	White cells	9870

Later History.—During the fore part of the month of December, 1914, the patient's temperature was at a low range, being between 98° and 99°, and the patient was feeling quite well. On the 24th, immediately prior to menstruation, she began to feel ill, her temperature went one degree higher than it had previously been. She had considerable pain in the pelvis, accompanied by nausea. This continued, with frequent vomiting for a period of ten days. She then seemed a little better; but again, about the middle of January, the vomiting increased. In spite of this, however, she increased in weight. The temperature at this time took a decided rise as a whole. The morning temperature, instead of being at 98.4° started at 98.6°. The diurnal variation was also slightly greater than it had been previously. On the 25th of January she weighed 114½ pounds which was one of her highest weights. At this time nausea increased and was almost constant, with a great deal of vomiting and much distress in the pelvis. On several occasions during the time that the patient had been under my care she had had symptoms referable to the appendix and at times had more or less difficulty at the time of menstruation, as will be noted from the temperature chart.

Pelvic examination showed a very marked tenderness on both sides, and the uterus sharply retroflexed. The reflex symptoms were so severe that she was taken to the hospital on the 6th of February, 1915, and operated on the 8th by Dr. Mattison.

When the abdomen was opened we found a condition that had never been suspected. There had been no symptoms whatever to give a clue to the pathological condition found.

The intestine was studded with tubercles from the pylorus to the sigmoid flexure. Most of the tubercles, however, were confined to the small bowel, the cecum, the ascending and transverse colon. The left ovary had a small cyst in it, and the tube, ovary and intestine were matted together. There were also adhesions between the right tube and the ileum.

The condition was so serious that it could not be relieved by any operative procedure so the appendix was removed and the abdomen closed as quickly as possible.

There are two points of exceedingly great interest in relationship to the intestinal condition found in this case. The first is that there were no symptoms referable to the intestinal tract except vomiting. This patient's appetite had been good and she had experienced no distress after eating. Her bowels were comfortable. She had shown slight constipation, but no diarrhœa; and, strangest of all, there had been no diminution in the absorption of nutriment. On the contrary she had been constantly gaining in weight. The second interesting point is that instead of the tuberculous foci ulcerating, they were nearly all fibrous and covered over by flakes of fibrin on the peritoneal surface. It would be intensely interesting to know what influence the tuberculin treatment had had in the result obtained here in the way of stimulating the fibrous tissue in the tuberculous foci.

History After Operation.—After the operation the patient made a slow recovery. She lost several pounds in weight, which she was unable to regain. She continued to have an irregular temperature, ranging a little over 99° to at times above 100°, for a number of months. She suffered, now and then, from pain in the abdomen. She also had a capricious appetite, and, at times, expressed a total disgust for food.

In the fall of 1915 she became excessively nervous, and found it almost impossible to control her feelings. She had periods of weeping. She also, at times, would show an aversion to people, and would become so annoyed by their presence that she would ask them to leave the room. This was very unusual because, under ordinary circumstances, she had a most amiable disposition and was very genial. She also manifested, during this period, a spirit of dissatisfaction and discontentment. This led her to look for a new location in which to live. She had some difficulty in obtaining a house; but, after several disappointments, finally secured one that was suitable and, during the strain of moving, practically collapsed.

During this period the lungs, which had been quiescent up to this time, began showing activity. She had been practically free from expectoration. Occasionally she would raise a few cubic centimeters which contained very few bacilli. She had also been quite free from cough. Immediately following the exhaustion attendant upon her moving (which came about Christmas time when she was busy with holiday preparations), she began to decline rapidly. She lost 4 or 5 pounds in weight, was unable to eat, suffered from insomnia, and was rapidly becoming so weak that, by the middle of February, she was no longer able to come to the office. Examination showed that the disease in the right lung which had been quiescent for a long period, had become active,—her old fibrosis had taken upon itself the ulcerative type. Considerable fever was present. During December of 1915, her daily range of temperature was from 98.6° to about 100.5° or 101° in the afternoon. This temperature, at first, was due to the extra activity in the lung rather than to the condition in the intestinal tract; but later both lesions were undoubtedly causing it. This type of temperature continued and became more severe as time went on. When she left the sanatorium on the 9th day of August, 1916, it was attaining a daily maximum of about 102 degrees.

I wish to call attention to certain very interesting features in the temperature and pulse curve during this last stay in the sanatorium, from February 18th until August 9th. It will be noticed that at no time during this long period was her temperature below normal in the morning except for a few days at a time. The maximum range of the body of her temperature curve was about 101°. Every now and then, however, the daily maximum would go to 102° and 103°, and even 104°. I would especially call attention to certain very high temperature records, one on the 21st of June, another on the 3rd of July, still others on the 10th, 12th, 13th, 14th, 15th, 16th, 17th, and 19th of July. It will be noticed on these days that the temperature remained under the 101° mark until in the late afternoon, at which time there was a sharp rise. These sharp rises were all due to excessive cough. This patient could not take codeine or heroin. Both of these preparations of opium produced a feeling of excitement, fear, and great depression. I thought that probably this was only a notion and attempted to give her these preparations concealed in such a way that she would not know that she was taking them, but the effect was just the same; so we found it very difficult to relieve her cough. Finally, it was relieved by Dover's powder, which she stood well. The reason for this excessive cough seemed to be the extensive contraction that was taking place in the right lung, which caused traction on the vagus. For the most part it was an unproductive cough. These spells of coughing would last sometimes for nearly an hour, in spite of everything that was done for her, and yet there would be comparatively little secretion raised. The cough was always worse when the patient was nervous. Whether the nervousness resulted from the cough, or fear of the cough, or whether the cough was due to a loss of nerve control, was difficult to say. I do not think that the temperature during these few months was wholly due to the lung, in spite of the fact that the lung was very markedly active. I am rather under the impression that it was a double process caused by inflammation in both the lung and the intestinal tract.

In favor of this assumption I would call attention to the pulse. This pulse shows evidence of strong vagus stimulation; and, at a time when the patient is suffering from a very marked toxemia which, under ordinary circumstances would produce sympathetic stimulation and cause rapid heart action. In the early days of March, 1914, the temperature showed a very marked upward wave, but it will be noticed that the pulse did not keep pace with the rise; and following this, there was a marked decrease in the pulse rate. While the body of the pulse continued in the eighties, the body of the temperature was reaching the 101° mark. Then it will be noticed, as the case proceeded, that during the latter part of June, 1916, while the temperature went very high, the body of the pulse curve was in the eighties. Such a degree of disproportionment between the normal maximum temperature and the rapidity of the pulse rate, is usually due to marked stimulation of the vagus. In this case the vagus stimulation was able to overcome the marked stimulation of the sympathetics produced by the toxemia; which, without such vagus stimulation, would have produced rapid heart action. It will further be noticed that during these months the diurnal variation of the temperature curve was for the most part 2° or more. This type of temperature indicates marked disturbance in the vasomotor mechanism. It will be noticed, however, that, at no time was there a subnormal temperature; consequently, we must infer that the patient's power of reaction was unusually good. With the degree of toxemia manifested here, if the patient's vital forces were rapidly declining, we would find a very low morning temperature, as low as 95° or 96°, while the afternoon temperature reaches 103° or 104°, as illustrated in Fig. 121, page 140.

During the latter part of this patient's stay in the institution, there was a general weakening of the abdominal supports taking place, which was resulting in a general ptosis of the organs, and a dilatation of the stomach was manifesting itself. The intestinal tract was also showing the symptoms which come from fibrosis and constriction of the gut, as pointed out in Volume II, Chapter XXIV.

We shall now attempt to describe the symptomatology which accompanied these complications.

The dilatation of the stomach manifested itself in a lack of appetite, a feeling of satiation after the swallowing of a very few mouthfuls of food; in fact, the patient complained of an inability to take more than a few mouthfuls at a time, saying that she could not force it down. At times there was some little pain in the epigastric region, but this was not common. Considerable gas formation was present, and insomnia was very marked.

The explanation of the symptoms of satiation is furnished by Hertz (Vol. I, Chapter X) and is as follows: Each time the patient swallows, there is a reflex stimulation from the esophagus, which relaxes the circular musculature of the stomach to prepare for the food swallowed. When the stomach is full the muscular coat is stretched and the patient has a feeling of satisfaction. When the stomach is already dilated, if food is swallowed, the esophageal reflex attempts to produce the relaxation which it would under ordinary conditions, but meets an already stretched muscle; consequently the feeling of satiation is experienced.

The treatment of such a condition is very difficult.

These symptoms, fortunately, are not always continuous, particularly at first; and it is important to build the patient up as rapidly as possible during the time when they are absent. Under such conditions it is desirable that the patient should chew his food thoroughly, and yet, there is such a disgust for it that this is impracticable. We find it necessary, on the contrary, to feed these patients with food that can be swallowed at once, such as milk and eggs, regardless of the desirability of having it thoroughly masticated and prepared for digestion.

A lack of acidity is often present during this time. This can be relieved by giving the patient dilute hydrochloric acid, 5 to 10 drops after meals. Strychnine is also recommended and is sometimes of value. Massage and electricity can also be used, but are of doubtful value. If the patient maintains a fair appetite, as is sometimes the case, it is best to restrict the liquid at meals and allow it to be taken between meals.

The Condition of the Intestinal Tract.—In spite of the widespread tuberculous infection of the intestinal tract, as shown at the time of operation, this patient, up to the last time of leaving the sanatorium had, at no time, shown any tendency to looseness of the bowels for more than a few days at a time. On the contrary, constipation was usually marked. It was necessary for this patient to have some aid beside that of laxative foods during a considerable portion of the time. This was sometimes given in the form of the aloin-belladonna pill, and, at times, in the form of some of the saline laxatives. At times, as previously mentioned, this patient complained of pain in the intestinal tract. This was relieved by hot fomentations to the abdomen, and by the use of atropin and menthol. Atropin has the effect of lessening the muscular activity. The pain in these cases is due to the fact that the tuberculous process has produced such a degree of fibrosis that it has reduced the lumen of the bowel, in some places almost to the point of closing. These points of constriction are now and then temporarily blocked by the bowel contents, which causes an accumulation of gas to take place on their proximal side. This distends the gut and causes pain. This is relieved by atropin. Menthol has proved to be a fairly satisfactory remedy for the prevention of gas, which often proves to be exceedingly troublesome in these cases. By the relaxing effect of the hot fomentations, and the counteracting effect of the atropin upon the intestinal musculature and the use of menthol, this patient was kept comfortable most of the time.

There can be but one outcome to a case such as this. The process will go on until the patient is exhausted. This patient should have recovered; and had the total amount of time spent

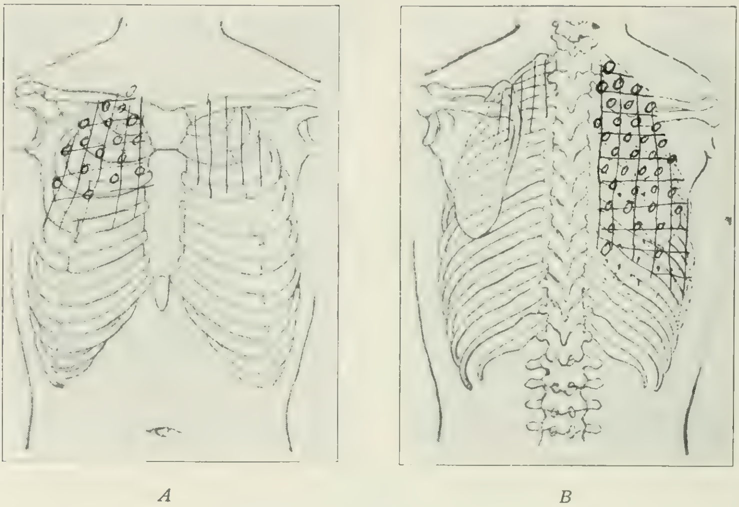


Fig. 162.—Charts of chest, Case 2383.

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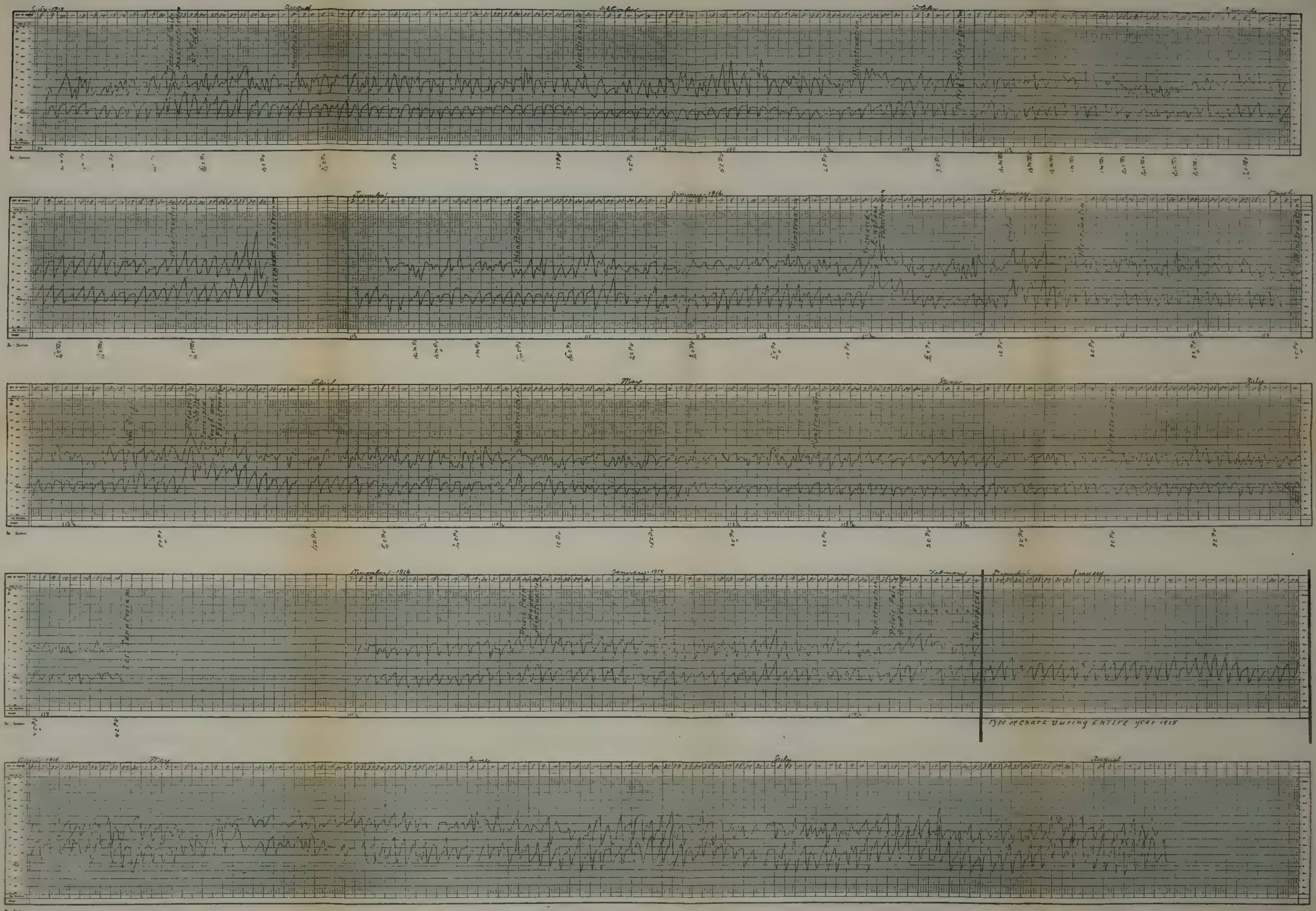

Fig. 163. Charts showing temperature and pulse curves, with clinical notes and doses of tuberculin, Case 2383. Upper curve, pulse, lower curve, temperature.

in treatment during the entire course of the disease been spent at the time when it would have been most valuable, there is no doubt but that the result would have been favorable.

This patient suffered because of lack of appreciation of the seriousness of her condition by those upon whom she was dependent for the funds for her care. She spent many months in the sanatorium, sufficient to have produced an arrestment at the time that she first entered the institution; but it was spent injudiciously. She would get better and then be removed from the institution, to be brought back after the disease had become more active. This is a condition which we are often forced to combat during the period of early tuberculosis when six or eight months' time spent in an institution will give the patient from 70 to 90 per cent chances of cure. The expenditure at this time is thought to be useless and extravagant; but, when this early favorable period passes, twice this amount of time will be given and twice the amount of money will be expended to no purpose. This is the most disheartening feature in the treatment of this disease. Could the patient and the friends be made to understand in some way that the time to treat tuberculosis is the time when it is curable, we would establish tuberculosis as a curable disease much more rapidly than by any other procedure.

CASE 2161.

DELAYED DIAGNOSIS; CHRONIC FIBRO-ULCERATIVE TUBERCULOSIS: COMPLICATED BY TUBERCULOUS ENTERITIS; OPERATED WITH RESECTION OF LOWER ILEUM AND ASCENDING COLON; MENINGEAL IRRITATION PROBABLY OF TOXIC ORIGIN; PULMONARY INFECTION HEALED; DEATH FROM INTESTINAL INFECTION; AUTOPSY. OBSERVED FROM JUNE 20, 1913, TO DECEMBER 3, 1914.

A Discussion of: The Relation of Fistula in Ano to Tuberculosis; Similarity of Symptoms in Tuberculous Enteritis and Simple Colitis; Pathological Findings.

Case 2161.—Clerk. Age 23. Entered the sanatorium June 20, 1913.

Family History.—No tuberculosis in family, except one grandfather who died of pulmonary and laryngeal tuberculosis.

Personal History.—Was a student until eighteen years of age, following which time he worked in a store. Had measles, whooping cough, and scarlet fever, with prompt recoveries. Had an operation on the nose, November, 1912.

Tuberculous History.—Following the operation on the nose in November, 1912, the patient lost weight and suffered a decline in strength. Shortly thereafter he had an operation for ischorectal abscess, and a little later noticed pain in the chest. He was examined and told that he had a "cold in the muscles;" was sent to Colorado in December, 1912, and returned home in April, 1913. He did not take particularly good care of himself, thinking that he was not ill.

For a month prior to his entering the sanatorium the patient suffered from the following symptoms: general lack of nerve tone, disturbed digestion, loss of weight from a normal of 155 pounds to 136 pounds; some hoarseness with attacks of supposed "cold;" and a tickling in the throat, and cough. In the preceding March had noted the beginning of expectoration, the amount of which was slight. Had no hemorrhage, no pleurisy nor night sweats.

These symptoms may be classified according to their etiology as follows:

SYMPTOMS DUE TO		
Toxemia	Reflex Stimulation	Tuberculous Process *per se*
Malaise	Hoarseness	Tuberculous bronchitis
Lack of endurance	Tickling in throat	Sputum
Nervous instability	Cough	
Loss of strength		
Loss of appetite		
Loss of weight		

Examination.—General appearance good, though pale. Temperature 99.6°, pulse maximum 85, blood pressure 106 on the left and 90 on the right. The patient was sleeping well. Bowels regular.

Condition of the Muscles and Subcutaneous Tissue.—The condition of the muscles and subcutaneous tissue is shown in the following table in which the — sign is used to indicate degeneration, and the + to indicate spasm. The degree of spasm and degeneration is indicated by the number of signs; one meaning slight; two marked, and three very marked.

	RIGHT		LEFT	
	Degeneration	Spasm	Degeneration	Spasm
Sternocleidomastoideus	— —	+		+ +
Pectoralis				
Trapezius	— —			+ +
Levator anguli scapulæ	— —			+ +
Rhomboidei				
Degenerated subcutaneous tissue	To second rib anteriorly and spine of scapula posteriorly			
Lessened motion	Slight		Marked	

Palpation of Total Resistance.—RIGHT.—*Anteriorly.*—Moderate resistance to the palpating finger to the third rib. *Posteriorly.*—Moderate resistance to the spine of the scapula. LEFT.—*Anteriorly.*—Marked resistance to the third rib. *Posteriorly.*—Marked resistance to the middle of the scapula. Moderate resistance also at left base, suggestive of pleural effusion.

Suggested Diagnosis from Inspection and Palpation.—From the fact that the muscles and subcutaneous tissue over the right apex is degenerated, we would infer that this has been the seat of an old lesion. From the fact that the sternocleidomastoideus shows slight spasm we infer that there is slight activity still in this process. From the fact that there is no degeneration, but marked spasm of the sternocleidomastoideus, trapezius and levator anguli scapulæ on the left, we infer that there is a recent active process at the left apex. The fact that palpation elicits resistance over the upper portion of both lungs also confirms the fact that there is some thickening of the underlying tissue.

Percussion.—RIGHT.—Moderate dullness to the second rib and spine of scapula. LEFT.—Moderate dullness to third rib anteriorly and to middle of scapula; also impairment at left base.

Auscultation.—RIGHT.—Harsh high pitched inspiration with harsh prolonged expiration over the apex. LEFT.—Rough harsh inspiration with prolonged expiration and many medium râles to third rib anteriorly and middle of the scapula posteriorly. At the left base the breath sounds were weaker; and pleural râles, the result of a recent effusion, were detected.

Laboratory Examination.—

Sputum:	Date	June 24, 1913
	Quantity	24 c.c.
	Bacilli	10 to the field
Urine:	Quantity	1600 c.c.
	Albumin	negative
	Sugar	negative
	Diazo	negative
	S. G.	1013
Blood:	Hemoglobin	85%
	Leucocytes	13,400

Diagnosis.—An old lesion at the right apex which is the seat of renewed activity. A new and more extensive lesion in the upper half of the left lung, which shows marked activity. Recent pleurisy at left base. The condition of the lungs may be inferred from Fig. 164, page 658.

Prognosis.—The prognosis in this case, as far as the pulmonary condition is concerned, was good, and an arrestment should have been expected.

Analysis of the Case.—This case illustrates an all too common occurrence in the early history of clinical tuberculosis. This patient undoubtedly had clinical tuberculosis before his nose was operated. It was probably the supposed "colds" with some of the reflex symptoms which point to the larynx, such as tickling in the throat and cough, that caused him to consult a nose and throat specialist. He then sought relief from his fistula. This was promptly operated without the real cause being suspected. This case illustrates the necessity of a careful examination of the chest when a fistula *in ano* is found. They are tuberculous in a large majority of cases and practically always secondary. The patient should rarely ever be subjected to an operation for the fistula if there is active tuberculosis in the lung.

After the operation the patient lost weight and declined more rapidly than before. He was sent to Colorado without a definite idea of his trouble and without adequate advice; and, as a result, obtained no benefit from the change. He had a good time and the disease progressed, as it so often does under such treatment.

He returned home in April and was soon suffering from an increase in symptoms. He consulted four physicians during these early months of symptoms, three of whom failed to detect any lung trouble.

The mistakes in this case were:

1. A failure to diagnose the disease early.
2. Operation upon a patient for fistula who was suffering from an active pulmonary tuberculosis; which should never be done unless the fistula is more dangerous than the pulmonary disease or is interfering seriously with the patient's chances of cure.
3. Sending the patient away without telling him the nature of his trouble.
4. A failure to provide intelligent treatment early.

Treatment.—On entering the institution this patient was put to bed and treated with the hygienic sanatorium regime, plus tuberculin with attention to complications as they arose.

Course of the Disease.—The temperature and pulse records are shown in Fig. 165. The patient gradually made improvement in his pulmonary condition, so that by December he was almost free from expectoration and bacilli. (Chart, at end description.)

In November he had an attack of pain in the region of the appendix, which was slight and soon passed away. Following this, however, his temperature showed slight disturbance and he did not feel so well; his chief complaint being those symptoms which usually accompany colitis. There was considerable gas and an inability to put on weight, no matter how much the patient ate. His appetite was fairly good and remained so until sometime later. The colitis was treated by regulating the diet, colon flushings, together with application of moist heat to the abdomen; but it did not seem to yield. There was no diarrhea present at this time. The patient consulted a stomach specialist who confirmed the diagnosis of colitis, not suspecting a tuberculous condition.

During the latter part of December and the early part of January the patient ran an irregular temperature. He was put to bed and the treatment outlined above was carried out faithfully.

Beginning on the 19th day of January the temperature assumed an increased diurnal variation and a higher plane, reaching 100° at first and later 101° and even 102°. The pulse remained the same as previously, between 80 and 90, in spite of the rise of temperature. This disparity between pulse and temperature is always suggestive of a vagus reflex from an intestinal lesion although it may result from pulmonary stimulation; so tuberculous enteritis was suspected.

There was no increase in cough; neither did the patient complain at first of suspicious symptoms on the part of the gastrointestinal tract. Later, however, he had one or two mushy stools a day. Physical examination revealed a mass in the right lower quadrant of the abdomen, and a diagnosis of appendicitis, probably of a tuberculous nature, was made. The head of the cecum and ascending colon were also tender to touch.

The patient was taken to the Pasadena Hospital on the 4th day of February and, on the 6th, was operated by Doctor Mattison.

At the time of the operation we were greatly surprised to find a very widespread tuberculous infection. It seemed, however, to be confined to the lower end of the ileum, cecum and ascending colon; so a resection was done, taking out twelve inches of the ileum, the cecum and entire ascending colon, the end of the ileum was then anastomosed to the transverse colon. At the time of the operation many mesenteric glands were found infected and enlarged, although the remaining portion of the gut did not seem to be infected.

Following the operation the temperature dropped to 99° and 100°, where it remained for about two weeks. Then it began to show a periodic rise, reaching a maximum of 101° to 102° at intervals of about two weeks.

The patient returned to the sanatorium on the second day of March. At that time he was having from three to five or six movements a day, with considerable pain in the abdomen.

It will be noticed in the chart (Fig. 165) that the temperature began to increase its diurnal variation. It will also be noted that the pulse remained low, between 80 and 90, and then later between 75 and 85. The wider diurnal variation in temperature kept up, the diarrhea continued and the pulse remained low until the end of June.

During July there was a remission in temperature during which time the pulse had a tendency to become a little bit higher. This was accompanied by a general feeling of improvement. The temperature became more irregular again during the latter part of July, and the diarrhea increased. The pulse was still somewhat higher, running from 80 to 100, showing lessened vagus stimulation.

This condition continued until the early part of October when the patient went into a state of unconsciousness, during which time he had several convulsions, with opisthotonos. The unconsciousness continued for five days, when consciousness again returned. A diagnosis of probable tuberculous meningitis was made, but later we were convinced that it was probably due to toxemia, and not a tuberculous metastasis.

Following this attack the patient's temperature continued for a period of a month in the neighborhood of 99°, occasionally reaching 100°. The pulse assumed a higher plane reaching from 90 to 110. The condition of the bowels remained fairly good, there being from two to four soft movements a day.

During November both temperature and pulse dropped to a lower level, the pulse remaining for the most part between 80 and 90, and the temperature ranging from 96° A. M. to 98° P. M. with occasional rises to 99° P. M., and sometimes over. The condition of the bowels remained about the same and during this time the pain was very much less.

The patient left the sanatorium on December 3rd, 1914, and was under the care of another physician until his death, which occurred January 10, 1915.

Postmortem.—The findings were made by another physician and reported to me as follows:

The lungs were healed.

On opening the abdomen it was found that there were many adhesions between the transverse colon and the gall bladder. Throughout the entire intestinal tract at intervals of a few inches there were constrictions due to the thickening of the lumen of the gut. Some of these were so small that a lead pencil would barely pass through them, the wall of the gut being one quarter of an inch thick. In some instances the sections of the gut between these constrictions were markedly pouched; and where the constrictions were greatest they were thin as paper.

Laboratory Examination at Termination of Treatment.—

Sputum:	Date	Nov. 18, 1914
	Quantity (24 hrs.)	1 c.c.
	Bacilli	11 in 15 min. search.
Urine:	Date	Nov. 18, 1914
	Quantity (24 hrs.)	500 c.c.
	Specific gravity	1030
	Serum albumin	negative
	Serum globulin	negative
	Sugar	negative
	Diazo	1/3
	Indican	normal
Blood:	Date	Aug. 10, 1914
	Hb.	55
	White cells	10550
	Lymphocytes	1100
	Arneth index	97
	Red blood cells	3,000,000
	Neutrophile stippling	moderate

Comment.—This case is extremely interesting from many standpoints, thus:

From the Standpoint of Fistula in Ano.—Fistula *in ano* is very often of a tuberculous nature. This fact does not seem to be sufficiently understood by the profession. Whenever fistula is present the patient should be told that the probabilities are that it is of a tuberculous nature, and it should be definitely understood that it is a metastasis from some other focus in the body, nearly always from a pulmonary focus. A patient suffering from fistula should have the lungs most carefully examined before other advice is given. It is a very common practice to operate the fistula regardless of other conditions present. Often this proves disastrous, the pulmonary lesion being increased in severity as a result of the operation; and very often the operation wound itself fails to heal. It is not infrequent to find a history of fistula preceding that of recognized activity in the lung by several years. If the fistula were taken to be a sign of active tuberculosis, and the patient given the advice that should be given him, the future clinical disease might be warded off.

From the Standpoint of the Lungs.—During the first few months of treatment the patient made very satisfactory improvement and secured an arrestment from his lung condition and during all of the illness following, including the operation and the severe intestinal disturbance, the lungs remained healed.

From the Standpoint of the Intestinal Tract.—We had the opportunity of seeing tuberculosis of the intestine develop and go on to a fatal ending, and also had the opportunity of observing it during its course at the operating table, and later postmortem.

The clinical symptoms that this patient manifested during the time that he was developing his enteritis were very slight, as I am convinced is usually the case.

Two or three months prior to the time of the operation he found that he was gradually losing weight. He lost four or five pounds and in spite of eating very heartily could not regain it. His appetite became capricious and he suffered considerably from gas in the bowel. His stools assumed a soft consistency. Another feature which appeared at this time was mental depression and a general dissatisfaction with everything. These symptoms persisted for one or two months before he complained of any definite localized pain.

It will be noted from this chart that there was a slight disturbance on the part of the temperature curve beginning on the 23rd of December and continuing until the marked rise on the 18th day of January, some two weeks before his operation.

Another symptom which is very noticeable in this case is the persistent low pulse. At the time of the acute involvement preceding the operation the pulse rate did not increase, and during all the after history, for the most part, it remained lower than would be expected from the amount of temperature that was present. The absence of diarrhea until after the operation, is particularly interesting, although a very severe ulceration was found on the operating table. Neither was pain during the early period as marked a symptom as might have been expected in this case. The pains that he complained of prior to the operation were of the same character as those which accompany a moderate colitis.

The way in which the patient stood the operation was also very interesting, there being no untoward effects, although a resection of nearly two feet of the intestine was done.

Following the operation the interesting factors were an almost immediate increase in the diarrhea, which continued, for the most part until death, probably partly due to the removal of the cecum and ileo-cecal valve, which normally retard the intestinal contents in their passage; and partly to the advancing tuberculous process in the intestine.

It was interesting to watch the mesenteric glands become inflamed, enlarge, and then decrease in size; also to observe tenderness on pressure develop over a large portion of the intestinal tract and gradually disappear. The time when the tenderness was developing was probably when the inflammation in the foci in the intestines was most acute. The intense gas pains which were present more or less continuously, especially after the operation, were easily accounted for by the many obstructions which were found throughout the bowel.

Why this early infection in the intestinal tract should have been more virulent and should have gone on almost wholly to ulceration, while the latter infection was a milder one, and resulted largely in the formation of fibrous tissue is difficult to understand.

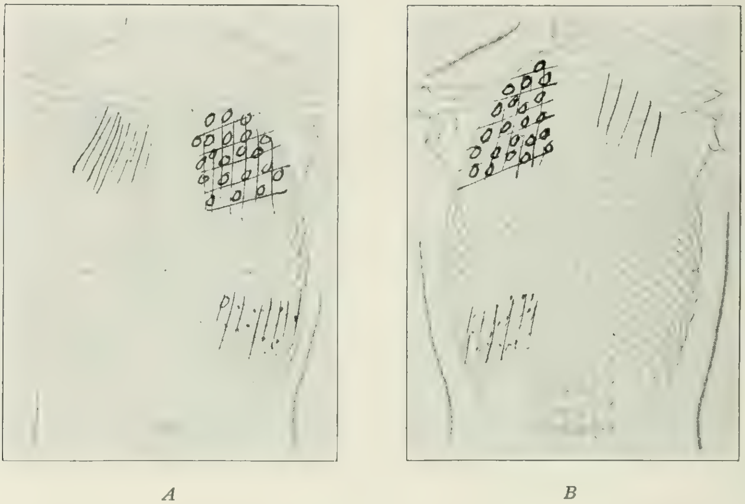

Fig. 164.—Charts of chest, Case 2161.

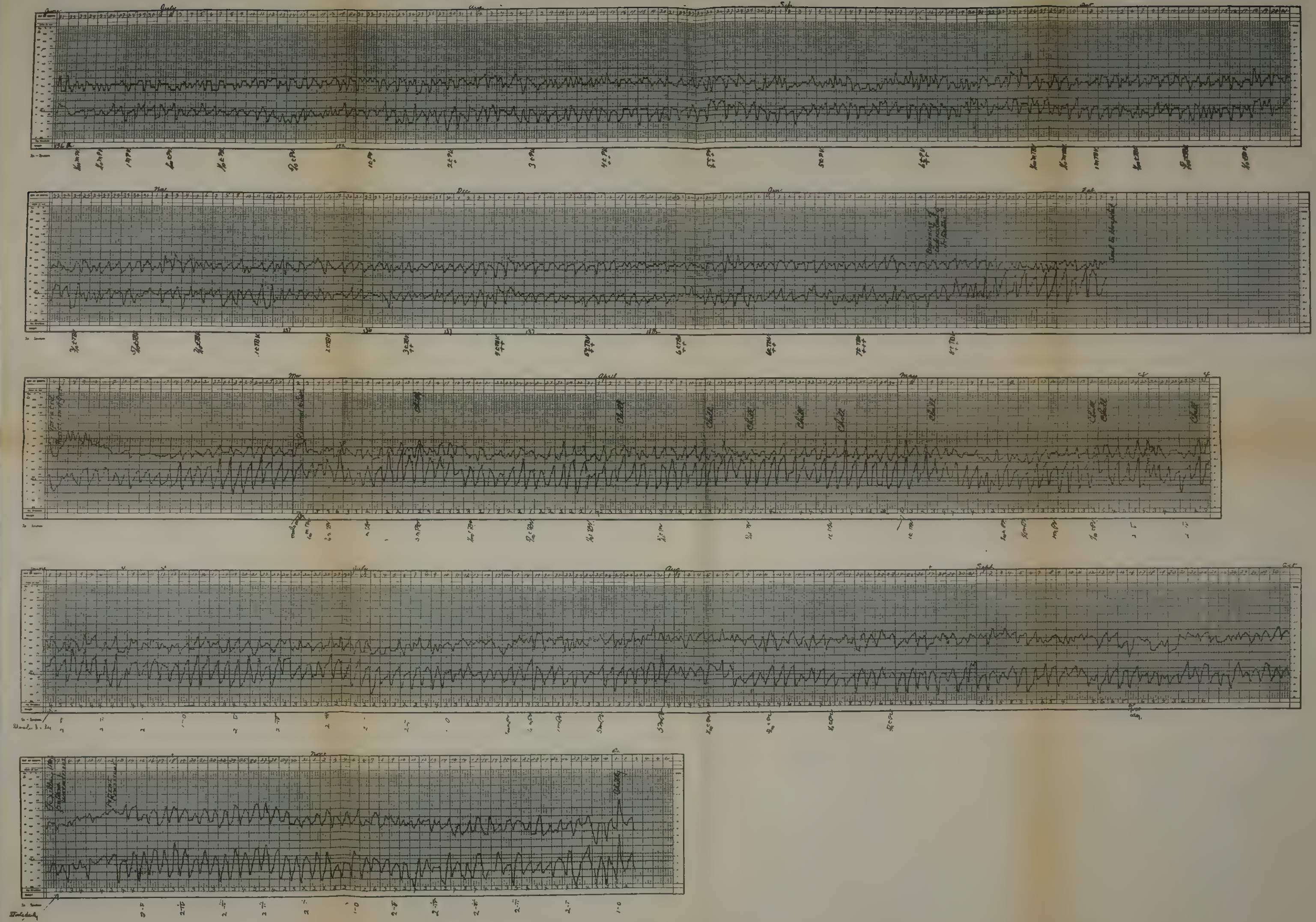

Fig. 165.—Charts showing temperature and pulse curves, with clinical notes and doses of tuberculin, Case 2161 Upper curve, pulse, lower curve, temperature.

CASE 2602.

CHRONIC FIBRO-ULCERATIVE PULMONARY TUBERCULOSIS COMPLICATED BY EXTENSIVE INTESTINAL TUBERCULOSIS; PERFORATION OF INTESTINE. DEATH.

Case 2602.—Physician. Age 30. Entered the sanatorium June 16, 1914.

Family History.—Family history revealed nothing of importance. Father, mother, two brothers, and five sisters all living and well.

Personal History.—Previous health good. Suffered from the ordinary diseases of childhood, with prompt recoveries.

Tuberculous History.—Two years prior to entering the institution, the patient suffered from pleurisy on the right side. During the same year he also had an attack which seemed to resemble influenza, and was so diagnosed, although later developments show that it was due to an active tuberculous process.

During the preceding year the patient had worked very hard mentally and physically. After a time he began to tire easily and noted that he was unable to do his work without great strain. He gradually began to lose in weight and lost, from a normal weight of 145 pounds, to 126¼ pounds. Eight months previously he developed a dry cough which did not abate. Three months previously he suffered from what was supposed to be a cold, and one month later had an attack of what was called influenza. During and following these attacks his progress was continuously downward.

During the three months previous to entering the sanatorium he suffered from some fever although he did not know how high it had been. He had slight hemoptysis and night sweats; some shortness of breath, but no gastric or other abdominal distress. Bowels were regular and movements normal.

Nutrition fair; maximum afternoon temperature 101.2°, pulse 86; blood pressure, systolic on the right side 115 and on the left side 105. He showed signs of an old lesion in the right upper lobe in which there was activity with areas of softening. The apex of the lower lobe on the right side also showed signs of activity. In the upper portion of the left lung there was a recent involvement which showed marked activity. The remaining portion of this lung was emphysematous. The condition of the lungs is shown in Fig. 166, and the temperature and pulse in Fig. 167.

Laboratory Examination.—

Sputum:	Date	June 19, 1914
	Quantity (3 days)	20 c.c.
	Sediment vol.	2 c.c.
	Bacilli per field	40
Urine:	Date	June 19, 1914
	Quantity (24 hrs.)	1050
	Specific gravity	1022
	Albumin	negative
	Sugar	negative
	Diazo	negative
	Indican	moderately increased

Treatment.—The patient entered the Pottenger Sanatorium. Was put in the open air with general hygienic, dietetic regime, with absolute rest in bed, and nutritious food. Aside from this he was given tuberculin and whatever symptomatic treatment was required at the time.

Course of the Disease.—During the six months that the patient was in the sanatorium he had a constant temperature, usually ranging from 100° to 101°, and often reaching 103°. The amount of breaking down in the lung checked, there was at no time an increase in the amount of expectoration; but, after four months' time the patient began to complain of some distress in the abdomen, accompanied by considerable gas and soft stools.

Physical examination at this time revealed a rigidity of the muscles on the right side of the abdomen, both of the lower and upper quadrant. Palpation did not produce pain at first. Later, however, we were able to distinguish an increase of rigidity, accompanied by pain on pressure, and found many enlarged glands in the mesentery.

During the latter part of November, his appetite entirely disappeared. His temperature continued about the same. The patient became very weak and his stools began to increase in frequency, there being two or three on some days. The patient died on December 13, 1914.

During the last week the patient showed symptoms which are common in death from tuberculosis. The temperature gradually lessened, owing to the patient's inability to react, and the pulse became more rapid. The patient made no complaint of any kind except of increasing weakness. Four days prior to his death he had an attack of extreme weakness, and faintness, which was accompanied by very rapid heart action. This was taken to be due to the heart itself, but proved to be due to a perforation of a large ulcer in the ileum.

After death it was found that the abdomen contained considerable fecal matter, which had passed into the cavity as a result of perforation of the intestines. The last four feet of the ileum and the ascending part of the transverse colon were found to be thickly studded with tuberculous ulcers, most of them running circularly around the gut. The mesenteric glands were enlarged.

Laboratory Examination at Termination of Treatment.—

Sputum:	Date	Nov. 7, 1914
	Quantity (24 hrs.)	60 c.c.
	Sediment vol.	6 c.c.
	Bacilli per field	30
Urine:	Date	Dec. 9, 1914
	Quantity (24 hrs.)	1400
	Specific gravity	1014
	Serum albumin	trace
	Serum globulin	negative
	Sugar	negative
	Diazo	1
	Indican	moderately increased

Comment.—There are several interesting factors in this case from the clinical standpoint.

First, Delayed Diagnosis.—Two years previous to my examination this patient suffered from pleurisy, also so-called influenza, which was unquestionably of a tuberculous nature. During the year previous to his entrance he again had repeated suspicious colds.

From the Standpoint of the Lungs.—It was interesting to note that while the patient had temperature continuously during the entire six months, the pulmonary disease did not spread. It made no headway. Increase of ulceration did not occur and yet conditions seemed favorable for a downward course.

From the Standpoint of the Intestinal Lesion.—The lack of severity in symptoms was surprising when compared with the abdominal condition found. From our physical examination during life we rather thought that the disease would not be so extensive in the bowel, but that it would be more of the glandular type, because the nodules were so distinctly palpable. We thought this also from the clinical symptoms. The patient did not suffer from great disturbance on the part of the intestinal tract. He had lost his appetite and had some gas pains, but these were not very severe. He had one or two mushy movements per day, such as would occur in cases of colitis of a simple nature; so we were not prepared to find the extensive tuberculous ulceration which was found.

Another interesting thing was that the stools had not shown large quantities of tubercle bacilli such as would be expected from such marked intestinal ulceration.

This patient showed a high indicanuria. During the six months he was in the sanatorium diazo was present only once.

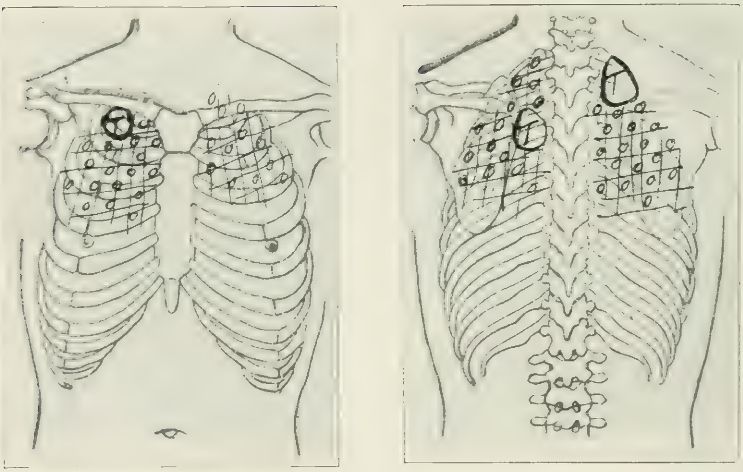

Fig. 166.—Charts of chest, Case 2602.

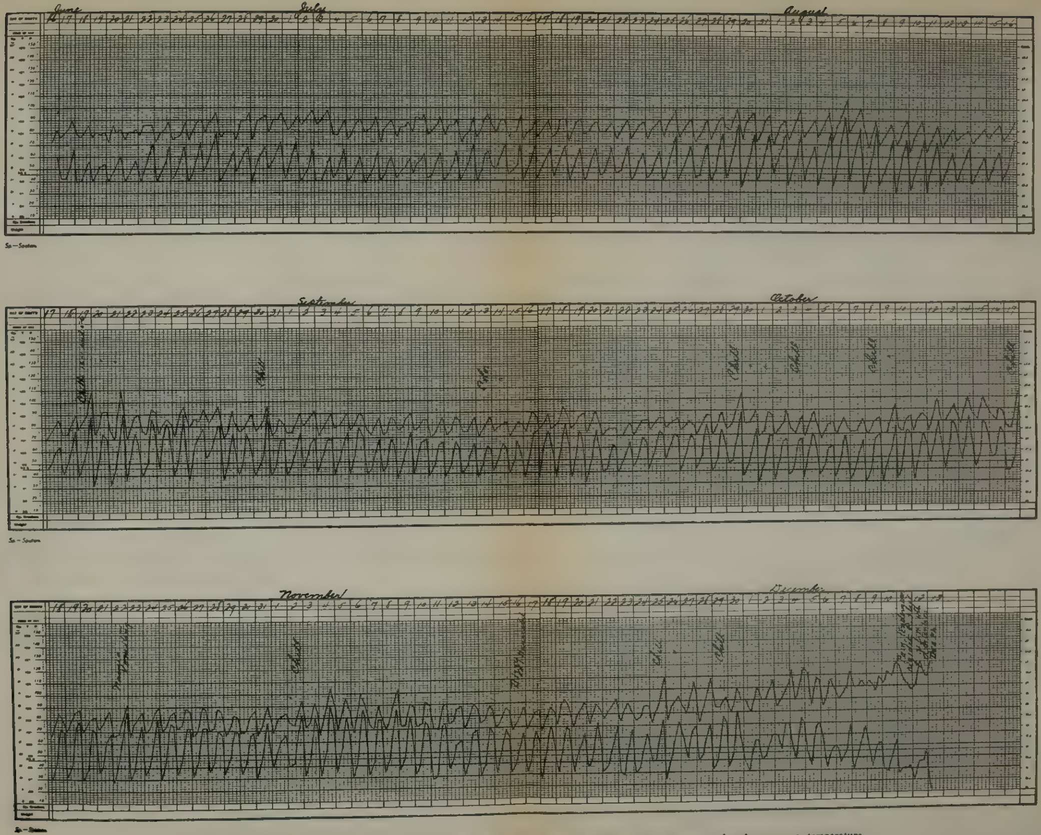

Fig. 167.—Charts showing temperature and pulse curves, with clinical notes. Case 2602. Upper curve, pulse; lower curve, temperature.

CHAPTER LI

INFLUENZA AND TUBERCULOSIS

The recent epidemic of influenza with its complicating empyema, pneumonia, pulmonary abscess, and persistent bronchitis and bronchiectasis, has afforded many difficult problems in diagnosis. It has also furnished a large proportion of cases in which the differential diagnosis between tuberculous and non-tuberculous infections has been exceedingly difficult.

While the exact cause of influenza is not known, it has been determined that many bacteria play an etiological rôle in the complex disease process as it manifests itself clinically. The influenza bacillus of Pfeiffer, pneumococcus, streptococcus, and staphylococcus were found most commonly, the relative preponderance of the individual germs differing greatly in different localities, and at different stages of the epidemic.

In the discussion of the relationship of influenza to tuberculosis we must consider several groups:

1. Those who were suffering from frank clinical tuberculosis before the influenza.

2. Those who had quiescent foci which were stimulated to activity by the influenza.

3. Those in whom pulmonary and pleural complications such as bronchitis, bronchiectasis, pulmonary abscess, fibrosis, empyema, pleural adhesions and pleural thickening remain, which must be differentiated from tuberculosis.

Effect of Influenza upon Active Pulmonary Tuberculosis.—It seems that those who were already suffering from active clinical tuberculosis withstood infection remarkably well. Not only were they not more prone to the infection, but on the contrary, they seemed to enjoy a certain resistance; which, while contrary to what many expected, is entirely in accord with the principle that there is not only a specific but also a non-specific resistance developed within the body as a result of an infection. This non-specific resistance to other infections on the part of the tuberculous has also been noticed during epidemics of other acute respiratory diseases and typhoid fever.

This same non-specific resistance helped the tuberculous patient in his struggle with the disease when he became infected. It was observed by many that the tuberculous patients withstood influenza even better than the non-tuberculous, that the disease was not so severe. While, in many cases the activity of the tuberculosis was increased, those complications which were so common in the lung and pleura of the non-tuberculous were not met more often; and, on the contrary, were apparently not so commonly seen in the tuberculous.

The effect on active tuberculosis, however, was in a great many cases to increase its activity. The process has been greatly hastened in large numbers of instances. In many cases a double process has presented: a chronic active influenzal infection and a chronic active tuberculous infection. Such cases have been very difficult to treat successfully.

The following analysis of the 169 patients who entered the Pottenger Sanatorium from October, 1918, to October, 1919, shows the relationship which their tuberculosis bears to influenza:

Fifty of these 169 patients gave a history of having had definite influenza during the recent epidemic. Of these 50, bacilli were recovered in 43 and 7 were non-bacillary. In the non-bacillary cases the diagnoses were based on the general clinical symptoms, physical examination, location, and nature of the lesion, tuberculin tests, x-ray examination and albumin reaction. In 18 the diagnosis of tuberculosis was made prior to the influenza. Twelve other cases gave a definite history of tuberculosis although the diagnosis had not been made. Twenty had frank tuberculosis prior to the influenza. It is interesting to note the classification of these cases at the time of entrance. Seven were classified as early, 17 as moderately advanced, and 27 as far advanced. This of itself is an indication that the disease in these post-influenzal cases has a tendency to take an active form. While it is too early to report on the final result of treatment in these cases, in a very large percentage the disease seems to heal more slowly than it does in ordinary cases of tuberculosis.

Effect of Influenza upon Quiescent Tuberculosis.—Many quiescent foci of tuberculosis are found in the lungs, especially of the adult members of our population. These are scattered throughout all parts of the lung. While they are found most commonly near the hilus and apex, they also are found in the lower lobes as well. No matter where these were located they were apt to be reactivated by the influenzal infection. Quiescent lesions did not furnish the degree of non-specific resistance which was noticed in the presence of active lesions. So, after the influenza passed away, in many cases there was observed a gradual development of a clinically active tuberculous lesion.

It is characteristic of post-influenzal tuberculosis that the seat of activity may be found in any part of the lungs. Clinical tuberculosis usually shows its primary activity near the apex and extends downward as the disease progresses; but post-influenzal tuberculosis may be found to begin near the base, in the middle of the lower lobe or in any other portion where a sleeping focus has been reactivated.

The atypical points of origin of the post-influenzal tuberculosis makes the diagnosis more difficult, especially when the influenza itself has left upon the lung gross evidence of its presence.

Some of these cases follow rather quickly after subsidence of the influenza and appear as active lesions within three or four weeks. In such cases the early toxic symptoms accompanying the development of the active tuberculosis are mistaken for post-influenzal weakness. In other cases the influenza fails to heal, temperature, cough, and other symptoms persist and increase in severity until after one or two months a full-fledged active tuberculosis is detected as complicating the picture.

The diagnosis in such cases is complicated by the fact that the active tuberculous focus may be in any part of the lungs; and further by the fact that it may be located in areas which are also the seat of post-influenzal pathology.

In many of these cases sputum exists from the time of the influenzal attack, but does not show bacilli until after it has persisted for some weeks. In such cases a negative bacteriological examination made early is often relied upon and the patient is considered as suffering from a non-tuberculous disease. Persistent activity in post-influenzal pulmonary lesions calls for repeated examinations of the patient and his sputum at frequent intervals until the diagnosis is established beyond doubt.

Post-Influenzal Pulmonary Lesions and Pulmonary Tuberculosis.—Most difficult problems in the diagnosis of chest conditions have arisen since the recent epidemic of influenza. In many instances it has been all but impossible to determine whether or not a given chest condition was tuberculous or non-tuberculous.

The old dictum that a localized bronchitis in one apex is to be considered as tuberculosis would not hold because the influenza and its accompanying pneumonia often affected the apex and left its signs there. The fact that localized signs were found in the middle of the lung or in the lower lobe, on the other hand, could not be considered as non-tuberculous, because old quiescent lesions in those areas were often reactivated by the influenza. So any case of post-influenzal lung infection must be studied on its own merits. There is also another phase of the problem which we are now beginning to meet, in which active tuberculous disease is found in areas which have long since ceased to show any active post-influenzal signs. These, too, offer difficulties of diagnosis.

There are several groups of post-influenzal chest conditions which must be differentiated from pulmonary tuberculosis, such as chronic empyema, chronic bronchitis, with or without bronchiectasis, and pulmonary abscess. These are frequently mistaken for tuberculosis; and one and all may complicate it.

Some cases of influenzal empyema assume a chronic form. In such instances circumscribed pockets of pus may form, and the patients show signs of toxemia. The temperature may assume either a low grade type or it may reach a high maximum. I have seen this occur in patients who had made a splendid temporary recovery after operation. In cases complicated by active tuberculosis the diagnosis is often difficult. The thickening of the pleura which often results interferes greatly with the examination of the underlying pulmonary tissue.

Chronic Bronchitis and Bronchiectasis.—Influenza in many instances left the patient with a chronic bronchitis either with or without bronchiectasis. The infection in the bronchial walls, results in their thickening and in many instances in their dilatation. Cough and expectoration may be present all of the time or they may appear only when the patient has a ''cold.'' These cases are apt to show periods of exacerbation of symptoms in which the cough and expectoration increase and temperature may be present. At times the sputum will be bloody. The cough, if frank bronchiectasis is present, is usually loose, indicating that the sputum is in the larger tubes where it is easily moved. The loose nature of this cough is of considerable diagnostic importance, and when persisting after influenza, is very suggestive of bronchiectasis.

The fingers sometimes show clubbing in bronchiectasis; but this sign is not as constant or as marked as in pulmonary abscess, and comes on much slower. It also is present at times in pulmonary tuberculosis, but comparatively rarely.

Pulmonary Abscess.—Not infrequently pulmonary abscess follows influenza. In most of the cases of this nature which have come under my care the abscesses were multiple and recurrent. This type has proved to be much more serious than the common single abscess following operations on the upper respiratory tract. It is frequently in the lower lobe near the base that we find abscess; but it may be in any portion of the lung. It is usually located in the tissue which is the seat of serious pathological change; and when near the base is often beneath a thickened pleura which makes for great difficulty in its detection. It is in pulmonary abscess that clubbing of the fingers comes on quickly and is so marked. I have seen it well marked in a few weeks from the onset of symptoms.

Differential Diagnosis Between Chronic Pulmonary Tuberculosis with Cavity, Bronchiectasis and Pulmonary Abscess.—In ordinary times bronchiectasis, abscess and pulmonary tuberculosis are infrequently found in combination in the same individual. Since the epidemic of influenza, however, we frequently find bronchiectasis and active tuberculosis, also pulmonary abscess and active tuberculosis present in the same individual. In some instances the tuberculosis was present first; in others the abscess and bronchiectasis were present first. So we must bear in mind that these affections are not only to be differentiated but also that they may be combined in the same patient.

In a recent paper* I discussed the points of differential value in these affections as follows:

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*Points of Differential Diagnostic Value in Pulmonary Abscess, Bronchiectasis and Pulmonary Tuberculosis, with an Explanation of the Cause of the Difference in Auscultatory Findings, Am. Jour. Med. Sc., October, 1919, clviii, No. 4, p. 502.

"*Inspection.*—On careful inspection a diminution of motion will nearly always be noted on the side of the involvement in all of these affections, because all reduce the elasticity of the lung tissue, cause a loss of tissue and produce a reflex diminution of motion through the diaphragm and other muscles of respiration. In pulmonary tuberculosis this may be difficult to ascertain in those instances in which there is a lesion in both lungs. In bronchiectasis the lung involved is practically always contracted and the mediastinum shifted toward that side (the degree of shifting in some cases is scarcely perceptible, in others very marked). In pulmonary abscess, contraction with shifting of the mediastinum may or may not take place, although it usually does if the process is a chronic one, the same as in tuberculosis.

"*Reflex Changes in Muscles and Other Soft Tissues Determined by Inspection and Palpation.*—The reflex spasm in the muscles and degeneration of the soft tissues—skin, subcutaneous tissue and muscles—is, as a rule, not as marked in pulmonary abscess and bronchiectasis as it is in pulmonary tuberculosis. The extent of the degeneration, when the process has become chronic, depends upon the extent and character of the previous inflammatory process. Pulmonary abscess is a focal infection in the lung. It may be single or multiple, but, as a rule, it appears as an acute disease in tissue which has not been, as is the case with tuberculosis, for a long time previously the seat of widespread foci of infection. Those abscesses which have followed our recent epidemics of acute respiratory infections, however, often occur near the base in the midst of areas of widespread fibrosis of pulmonary and pleural tissue. Bronchiectasis is, as a rule, limited in the amount of tissue involved. Like pulmonary abscess and unlike pulmonary tuberculosis it is rarely found in the midst of numerous active foci of infection. Pulmonary tuberculosis, on the other hand, when it becomes an active clinical process with cough, expectoration and cavity formation, is nearly always a chronic disease, and the cavity is formed in tissue which, as a rule, is and usually has been for a long time, the seat of many foci of infection which have been undergoing all degrees of active inflammation. The result is that pulmonary tuberculosis offers the greatest opportunity for reflexes. The muscles of the shoulder girdle and diaphragm are more tense (increased tension in the latter is inferred from the limited motion) during the activity of the tuberculous process than is the case in other diseases. When the disease becomes chronic these muscles and the soft structures (skin and subcutaneous tissue) in the neck and down to the second rib anteriorly and the spine of the scapula posteriorly show far more reflex trophic changes in tuberculosis than in the other two diseases. In fact, chronic tuberculosis of the lung may be suspected whenever the neck muscles and subcutaneous tissue and skin of the neck and chest above the second rib anteriorly and the spin of the scapula posteriorly are markedly degenerated. Pulmonary abscess and bronchiectasis also cause degeneration in these same tissues, but, as a rule, it is not so extensive, and I have seen instances of these affections which caused practically no reflex trophic changes." Thickened bronchi of influenzal origin do not cause degeneration of the skin and subcutaneous tissue in the interscapular areas like we find following extensive tuberculous inflammation of the mediastinal glands, but cause degeneration above the spine of the scapula, because they belong to the pulmonary structures while the glands are extrapulmonary.

Palpation and Percussion.—Percussion may give little or much information in abscess and bronchiectasis, but is of far more importance in pulmonary tuberculosis. Palpation has been of more aid to me than percussion.

Auscultation.—On auscultation the signs elicited in pulmonary tuberculosis with expectoration are usually more or less definite. If a cavity is present in active tuberculosis it is found in the midst of actively diseased tissue, which usually gives rise to characteristic respiratory sounds and many râles; if chronic, the tuberculous process outside of the cavity may be partly or wholly healed, under which circumstances the signs elicited on auscultation may be similar to those of pulmonary abscess. The signs of pulmonary abscess and bronchiectasis, as determined on auscultation, are usually few and often very indefinite. In fact, the nature of the process may be suspected from this fact; a definite history of cough and expectoration usually of a fairly large quantity, sometimes even several ounces a day, and comparatively few signs of moisture on auscultation.

Explanation of Different Auscultatory Findings.—If the examiner only can form a true conception of why there are marked changes on auscultation in pulmonary tuberculosis, and why even with larger quantities of sputum, as is often the case, there is such an absence of changes on auscultation, in pulmonary abscess and bronchiectasis, then the differentiation of these affections will be easier. This I shall attempt to show graphically by the accompanying illustrations.

The explanation of this fact is based upon the difference in pathology as mentioned above when considering the reflexes which arise from these processes.

Mucous râles or crepitations may or may not be elicited over cavities, depending on whether or not the mucus which they contain is disturbed by the ingress and egress of air. Rhonchi are sometimes heard over them. Conditions which favor the production of the most constant and greatest quantity of pulmonary râles are not found in the cavity itself but in the surrounding tissue as noted in pulmonary tuberculosis.

The relative prominence of râles in these three affections may be illustrated by the accompanying figures:

Fig. 168 illustrates the conditions present in pulmonary tuberculosis. A large cavity *A* has formed near the apex. It will be noticed that this has taken place in an area which is the seat of a widespread tuberculous involvement, as illustrated by the dotted areas *B*, throughout which there are numerous small cavities *C*. Here we have the ideal conditions for the production of crepitations and mucous râles: inflammation with foci of necrosis involving the walls of air cells and bronchi accompanied by an increased production of mucus which must find its way toward the trachea through bronchi of all sizes. The cavity itself is at times the seat of coarse râles, at other times no râles are elicited over it. Not infrequently I have seen the sudden disappearance of râles take place over an area of tuberculous infiltration as a result of cavity formation.

Fig. 169 illustrates the condition present in pulmonary abscess. An abscess *A* has formed as a result of acute bacterial infection. As a rule the first pulmonary abscess which forms is an acute process coming on, usually, within a few days after the implantation of bacteria has occurred. The surrounding tissues may not be at all infected. This is particularly characteristic of those abscesses which follow operative procedure upon the upper respiratory tract.

The abscess often forms in a single focus the same as a boil forms on the surface of the body. When the pressure in the abscess becomes sufficiently great, rupture occurs at the point of least resistance, which is usually into a bronchus.

A pus-forming pocket remains which discharges through the bronchus. The conditions in the surrounding tissues which favor the production of crepitations and râles as shown in pulmonary tuberculosis in Fig. 168 are absent and the chief source of whatever râles may be present is the abscess cavity itself and the bronchus or bronchi which drain it. The result is that crepitations and mucous râles are few in abscess produced by acute infections as compared with the abscess cavities which accompany pulmonary tuberculosis, unless the latter have existed for a long time and the tuberculous involvement of the surrounding tissue has healed.

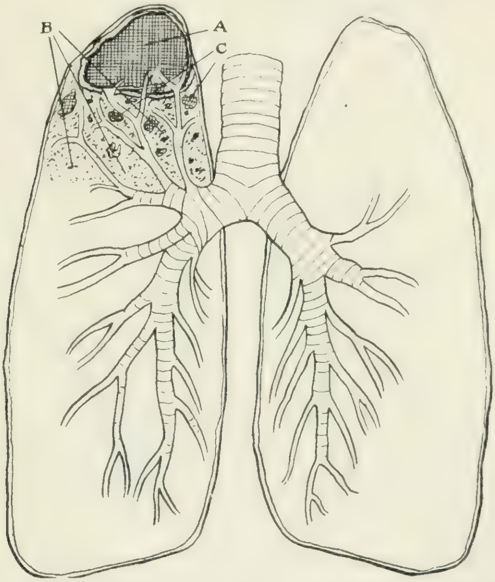

Fig. 168.—Diagrammatic illustration of a cavity due to pulmonary tuberculosis. The cavity *A* is surrounded by tissue which is the seat of tuberculous infiltration *B* and which contains many small cavities *C*. These are ideal conditions for the production of râles.

When multiple abscesses form in non-tuberculous lesions, as they sometimes do, particularly in those cases which become chronic, each one repeats the same cycle of events as noted in the acute single abscess. Varying amounts of scar tissue result, but still the widespread inflammatory and destructive processes which characterize tuberculosis and which favor so greatly the production of crepitations or mucous râles is absent. If the infectious process in either pulmonary tuberculosis or pulmonary abscess involves the pleura and other soft structures, then crepitations may be present which may be differentiated from pulmonary râles only with great difficulty and sometimes not at all.

Much the same condition is found in bronchiectasis as far as the production of râles is concerned as has just been described in pulmonary abscess. The bronchi are dilated and their walls thickened, as shown at *A* in Fig. 170, in such a manner that the dilatations have much the same physical appearance as abscess cavities. The surrounding tissue is thickened, fibrous in nature and offers little opportunity for the production of crepitations and mucous râles. At times there is constriction of the bronchi proximal to the dilatation which may favor accumulation of secretion and cause sounds on auscultation: but there are rarely heard

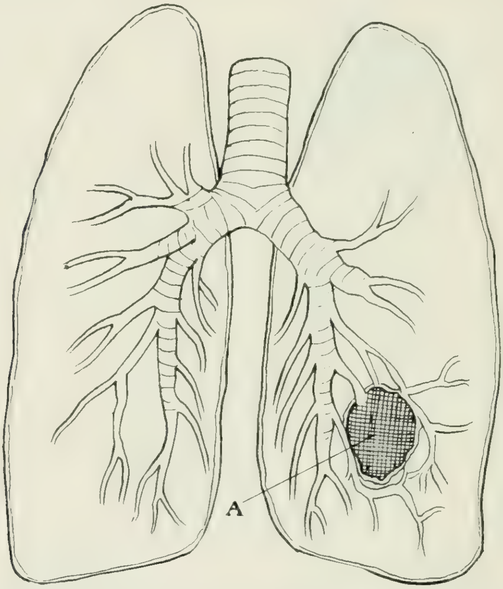

Fig. 169.—Diagrammatic illustration of acute pulmonary abscess. Abscess *A* is situated in the midst of, and surrounded by, healthy pulmonary tissue. The source of râles is the cavity itself and the bronchi leading from it. This condition is not favorable to the production of many râles.

on auscultation, either in abscess or in bronchiectasis, sounds which will afford any idea at all of the extent or seriousness of the pathological process present.

A history of persistent expectoration of moderate or large quantities of sputum, with a diminished respiratory excursion on one side of the chest and an absence or paucity of crepitations or mucous râles on auscultation over the side affected, should make one think of pulmonary abscess or bronchiectasis. Rhonchi are often present, but they too may be absent.

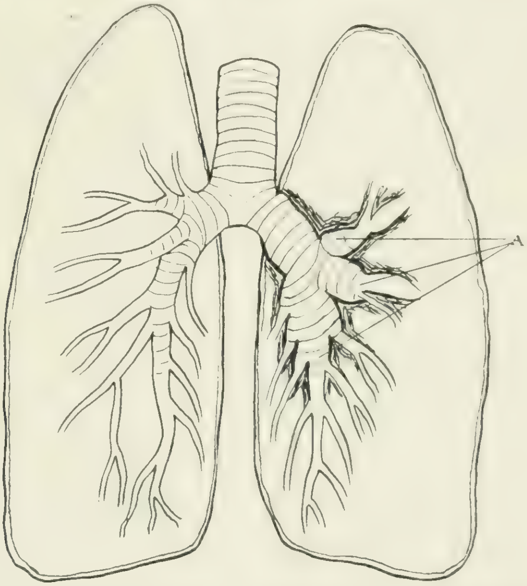

Fig. 170.—Diagrammatic illustration of bronchiectasis. The bronchiectatic dilatations *A* are surrounded by pulmonary tissue which is not the seat of infection; consequently the main source of râles is the mucus which forms in the dilated bronchi. This condition is not favorable to the production of many râles.

It may be inferred from this discussion that while the differentiation of these conditions is not so difficult when they occur singly, when two or three exist in the same patient the diagnosis is complicated. Fortunately, it is only after such epidemics as the one through which we have just passed that these various complex pictures are commonly met."

Treatment of Post-Influenzal Pulmonary Affections.—These post-influenzal pulmonary affections whether complicated by tuberculosis or not offer difficulties in treatment. If tuberculosis is a factor it is often of a more virulent character than the disease usually met; and the non-tuberculous lesions respond less readily to treatment than those of a tuberculous nature.

In my experience the general treatment of all these affections is the same. The hygienic, dietetic, open air régime, with rest during activity of the process, helps to preserve strength and raise the resistance for fighting the infection, no matter what its nature.

In my experience the general treatment of all these affections to meet the demands of each condition.

In some cases of abscess the lung may be compressed to advantage; in others operation may afford relief. The location of the abscess, its nature whether single or multiple, and the character of tissue in which it is located will have much to do with the decision as to the desirability of operative procedure.

Vaccine, either homologous or stock, may be used and in some cases has undoubtedly afforded some aid.

When the process loses its acute character iodine is of value. It may be conveniently used in the form of tincture, beginning with three drops and increasing to twenty drops, in milk three times a day after meals; or in the form of syrup of hydriodic acid; or as iodide of soda. It should be used over long periods of time, in some cases, months. Intervals of rest for two or three weeks may be interposed occasionally, but the remedy must be persistently used if an effect is to be had. I have seen several abscesses heal during the past three years treated along these lines, two of which were extensive, the expectoration amounting to five or six ounces a day.

Bronchiectasis requires the same character of treatment and will sometimes improve although complete relief is rarely attained. I have seen success in a few children, and improvement in some adults; but this affection is one of the most unsatisfactory that we have to treat.

Pulmonary tuberculosis complicated by these post-influenzal conditions must be considered as more serious than ordinary tuberculosis and must have all the aid that can be directed to it if a result is to be expected.

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